An analysis of hospital admissions for ambulatory care sensitive conditions

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Abstract

Aims

To define and identify 'ambulatory care sensitive' (ACS) and 'ambulatory care insensitive' (ACI) conditions.

To assess the quality of the NHS hospital episode statistics (HES) dataset.

To assess the reasons for variation in hospitalisation for ACS conditions across small areas.

To discuss whether variations in admissions for ACS conditions could be used to indicate equity of access to primary care.

Main subjects

Hospital admissions for residents of North West Thames NHS region 1991/2, 1992/3, 1993/4.

Methods

A modified nominal group technique was used to identify ACS and ACI conditions. The quality of HES was analysed by measuring shortfalls in key fields and the reproducability of clinical coding. Factors influencing variations in hospitalisation were assessed using multivariate analysis. The results were compared to similar studies from the US and Canada.

Results

30 ACS and 66 'weakly ACS' conditions were identified. Only 5 out of the 16 main acute providers serving the North West Thames region had adequate HES data across all three study years. In two providers, the *exact* clinical codes for main diagnosis could be reproduced in 43% and 60% respectively, and the *first 3-digits* of the ICD-9 codes in 55% and 72%.A significant positive relationship was found between admissions and socioecononomic deprivation independently of indicators for mortality and morbidity. This was weaker than that between admissions and area income found in the US and Canada. The relationship with deprivation was stronger for ACS than ACI conditions. A significant and positive relationship was found with an indicator of access to hospital care, but not access to primary care. The overall explanatory power of the model was weak at 10-20%.

Conclusions

Admissions for ACS conditions are higher in deprived areas, suggesting that access to ambulatory care may be lower. Higher rates of ACS conditions in poor areas in North America suggest lower access to timely and effective ambulatory care than in the UK NHS.

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Chapter 1 Introduction

This study is essentially an inquiry into the equity of an aspect of access to health care in the UK National Health Service (NHS).

John Billings and colleagues in the US studied hospitalisation rates of people living in low-income compared to high-income areas in New York City (1). The study focused on admission rates for three groups of conditions: so-called 'ambulatory care sensitive' (ACS) conditions; 'markers'; and 'discretionary surgeries'.

ACS conditions included those for which an admission to hospital was thought to be preventable by 'timely and effective' ambulatory care (such as diabetes and asthma). 'Ambulatory care' included pre-hospital care which was not provided in an inpatient setting, such as primary, outpatient, community health and accident and emergency care.

The study found that residents aged under 65 years living in low-income areas were hospitalised for ACS conditions over five times more than the rate of those in the same age group living in high- income areas, and almost 70% of the variation was associated with the average income of the residents of the area. Because of a lack of area-based data on prevalence of disease (one indicator of 'need'), Billings' *et al* were unable to take this factor fully into account in the analysis. However survey data showed that the prevalence of two of the commonest ACS conditions (asthma and diabetes) was approximately three times higher in low- relative to high-income groups - much lower than the variation in ACS rates observed.

In contrast there was no significant difference in admission rates between areas for the second group of conditions analysed - 'marker' conditions (those for which admission was thought to be relatively ambulatory care-*insensitive* and for which admission was thought to be urgent and 'mandatory' (such as fractured femur and appendicitis)). Admission rates for a third group of conditions - high cost 'discretionary' surgical procedures (such as joint replacements, coronary artery bypass surgery) - were found to be approximately half in residents of low-income areas compared to the high income areas, with area income explaining just over 20% of the variation.

Billings *et al* suggested that residents of low-income areas were less likely to have adequate health insurance cover. As a result, they would have less access to 'timely and effective' ambulatory care, and were likely to be admitted to hospital more often for conditions that could be managed in an ambulatory setting. Hospitalisation rates for ACS conditions were therefore used in the study as an outcome measure for equity of access to 'timely and effective' ambulatory care. Inadequacies in health insurance cover for residents of low-income areas could also lead to poor access to high cost 'discretionary' surgeries, and hence the lower admission rates observed for this population group. In contrast, Billings argued, access barriers to mandatory and emergency care, required for patients with marker conditions, were less evident in this population.

In those aged under 65 years examined by Billings *et al*, variation in admission rates for ACS conditions between low and high income areas was greatest for those aged 25-64 (those least likely to have adequate health insurance cover) and lowest for the under fives (a higher proportion of which had access to the state funded health insurance programme, Medicaid, compared to other age groups). Billings *et al* repeated the analysis using admissions data for the age group 65 years and older, almost all of whom qualified for Medicare (federally funded health insurance). Again there was an inverse relationship between income and admission rates for ACS conditions, but the variation was three-fold rather than five-fold seen in the under 65 years group. Again admission rates for marker conditions were similar between low- and high-income areas. Billings *et al* suggested that differences in ACS admission rates across age groups reflected the relative access to insurance coverage (and, in turn, ambulatory care).

Billings' findings were perhaps not surprising given the inequities of the US health care system, the barriers to accessing health care for those on low income, and the relative lack of investment in primary care. Similar analyses were subsequently carried out in Canada (2) and Spain (3) - countries with more egalitarian health systems compared to the US. Much less variation across small areas between socioeconomic groups was found. These findings raised the question of whether variations in hospitalisation for ACS conditions could be used as an indicator of equity of access to ambulatory care in a country.

The UK NHS scores highly on equity criteria compared to most other countries (4). Over 98% of the population are registered with a general practitioner (GP) who usually works in a group practice. Care is largely free at the point of use, with approximately 20% of the population subject to user charges (mainly for prescription drugs), and the NHS provides near comprehensive coverage of health benefits. Nevertheless inequities in access to ambulatory, particularly primary care, remain, particularly in cities, and especially in London. Given this, would the pattern of admission rates for ACS conditions be similar to that observed in the US, or more like that observed in Canada or Spain? If there were variations in admission rates for ACS conditions between residents of socio-economically deprived compared to less deprived areas, how much of this could be due to lack of access to 'timely and effective' ambulatory, particularly primary, care provided by the NHS? If so, could the relationship between the level of access to primary care and admission rates for ACS conditions be quantified in some way?

These questions were the starting point of the work presented in this thesis. The overall aim was to identify patterns of admission rates (by small area) to NHS hospitals for ACS and marker conditions, and to investigate reasons for the variations. Several hypotheses were to be examined:

- that rates of hospitalisation for ACS conditions would vary across areas more than would be expected by chance;
- that hospitalisation rates for marker conditions would vary across areas randomly;
- that higher hospitalisation rates for ACS conditions would be found in more socio-economically deprived areas even after adjusting for health care 'need';
- that higher hospitalisation rates for ACS conditions would be significantly associated with lower access to primary care facilities.

To investigate these hypotheses, an ecological cross-sectional study was proposed in which hospital admission rates for ACS and marker conditions were to be analysed by small geographical areas. It was intended that the analysis would be confined to hospitalisations of residents living within the former North West Thames region over a period of three years 1991/2, 1992/3 and 1993/4. Analysis of Billings' third group of conditions - discretionary surgeries - was not proposed because a significant proportion of admissions for these conditions in the UK occur in the private sector for which data are not routinely available.

But before the analysis could begin, three preparatory pieces of work were required. First it was necessary to identify and select groups of admissions which were to be analysed further. In particular there was a need to identify a list of conditions which UK clinicians agreed were 'ambulatory care sensitive' and 'markers': given the likely differences in clinical practice style between the US and UK it was thought inappropriate to rely upon the list of ACS and marker conditions derived by US clinicians. Since admission rates might vary simply due to data error it was necessary to assess the quality of routinely collected admissions data. Thus the second piece of work was an investigation of the *completeness* of routine data on hospital admissions in North West Thames region. The third was an investigation of the *quality of diagnostic coding* of routine admissions data, because admissions for specific conditions were to be analysed.

The thesis is therefore set out as follows:

- chapter 2 contains a review of related published work, and defines the scope of the study;

- chapter 3 describes how groups of admissions were identified and selected for further analysis, in particular how 'avoidable' and 'marker' conditions were identified. In this chapter there has been a substantial contribution to the analysis by Dr Colin Sanderson, and the chapter draws on a paper published in the Journal of Health Services Research and Policy in October 2000 (5). Jennifer Dixon was largely responsible for : the conception and design of the study; conducting the study; carrying out the initial analysis, the initial writing up of the paper; and all of sections 3.4 and 3.5 of the chapter. Colin Sanderson was largely responsible for further analysis and final drafting of the paper, in particular the results and conclusions;

- chapter 4 describes the completeness of data on hospital admissions within North West Thames region and the criteria for selecting, for further study, the hospitals with the best quality data;

- chapter 5 describes the investigation into the quality of diagnostic coding of hospital admissions data. This chapter draws on a paper published in the Journal of Public Health Medicine in 1998 – a paper contributed to by a number of individuals (6). In the chapter Jennifer Dixon was responsible for the conception and design of the study, obtaining funding, managing the fieldwork (conducted by clinical coders), analysis of the results and writing up. The other authors made such contributions as providing advice on the sample size, advising on the study design, designing a computer programme to enable coders to enter their data directly onto a laptop computer, and commenting on drafts of the paper;

- chapter 6 describes the small area analysis. Colin Sanderson contributed to the overall design of the study, in particular in simplifying the regression model used, helping to decide on the formula to be used to calculate the access factors, and suggesting which of the many results should be presented. Peter Walls helped mainly to calculate the access factors, as well as providing the dataset in a form that could be analysed by me;

- chapter 7 summarises the main findings, suggests next steps for analysis, and outlines the direct implications of the study for the NHS.

Because some of the chapters are long, to help the reader a schematic outline is shown at the beginning of each chapter.

Chapter 2 Literature review

2.1 Introduction

The study aims to investigate equity of access to ambulatory care in the UK NHS by area, using hospitalisation rates for ambulatory care sensitive (ACS) conditions as an indicator of access to ambulatory care.

The first aim of the literature review was to clarify the concept of equity in health care to be used in the study. The second was to examine the concept of access. The third was to examine how researchers had used hospital admissions as a negative indicator of access to 'upstream' care - timely and effective ambulatory care. The fourth was to summarise briefly the results of some of the published studies that have investigated variations in access to, or use of, health care, specifically to identify the main factors associated with the variations. The fifth was to consider methodological issues when conducting small area analyses of hospitalisation rates. The sixth was to outline the implications of the literature for the design of the proposed study.

This chapter contains some long sections. To help the reader, at the beginning of each section a box summarises an outline of the contents.

2.2 Equity in health care

<u>Section outline</u>

2.2.1 Concepts of equity
2.2.2 Concepts of need
2.2.3 Measuring need
- **(a) self-reported illness**
- **(b) socioeconomic deprivation**
- **(c) mortality**

2.2.1 Concepts of equity

Equity (justice or fairness) is a broad issue which has inspired extensive research and discussion amongst many, including philosophers, economists, and politicians. The more specific concept of equity in health and health care has also been widely discussed. Mooney (7) offers several definitions of equity in health care which include:

- equal resources per capita;
- equal inputs per capita;
- equal health per capita;
- equal access for equal need;
- equal use for equal need;
- equal treatment for equal need;
- equal outcomes (health) for equal need.

It is not the objective here to provide a background to the debate, to discuss the pros, cons and inconsistencies of each of the equity principles outlined above – there is an extensive literature on the subject*. Disagreement remains over which principle is best to use, although the definition most often used in research to assess equity in health care is 'equal access for equal need'. Here I simply seek to clarify this definition, which will be used in this thesis.

Two dimensions of equity are usually discussed in the literature – 'horizontal' equity (the equal treatment of equals) and 'vertical' equity (the unequal treatment of unequals) (7). Neither dimension is as straightforward a concept as it first appears (8). For example, measuring the extent of horizontal equity in health care presents difficulties because of the problems in assessing which individuals have the same needs. Vertical equity - unequal access for unequal need, for example different levels of use of health care for different levels of illness - has presented the added problem for researchers involving judgements about exactly how much differential access is appropriate for differing levels of 'need'. This judgement is necessarily subjective and often arbitrary. Instead researchers have tended to investigate whether or not higher levels of 'need' are associated with higher levels of access, rather than being concerned with *how much higher*.

These difficulties are compounded because both 'need' and 'access' are complex concepts and are difficult to measure directly. Need is considered below; access is discussed in the following section.

2.2.2 Concepts of need

There has been much debate as to what 'need' for health care actually is. Bradshaw (9) defined need as including:

- 'felt need' – where an individual or group perceives a need;
- 'expressed need' - where an individual or group turns 'felt need' into action (ie through a demand);
- 'normative need' – 'that which the expert or professional, administrator or social scientist defines as need in any given situation';
- 'comparative need' – where an individual or group with specific characteristics is not receiving the same services as others with the same characteristics.

In a comprehensive and useful review of the literature on access to health care, Goddard and Smith suggest that an individual's 'need' for health care can include two related but separate issues - the individual's *level of illness*, and their *capacity to benefit* from treatment (10). The authors go on to pose further questions:

- to what extent should non-clinical contributions to need be considered? (such as an individual's social circumstances or their preferences);
- how is the relevant concept of health status to be measured? (for example can 'self-reported' health status be relied upon?);
- at what stage should need be measured? (for example at the point of demand or at the point of treatment?).

Goddard and Smith note that most empirical studies 'have paid scant attention' to the concept of need and tend to make crude assumptions, for example that levels of need are

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* For a useful introduction and discussion see Le Grand 1991 (32), Mooney (25) and Culyer (28).

either:

(a) the same in the population groups studied; or

(b) assessed on the basis of 'self-reported' health status, thus ignoring the potential variations between population groups in the way that health status is interpreted and reported in surveys. Furthermore a self-reported level of health gives no indication about the individual's capacity to benefit; or

(c) assessed on the basis of a bio-medical measure, thus ignoring the potential systematic variation in the measurement, and the influence on need of unmeasured factors (such as socioeconomic circumstances); or

(d) indicated by the characteristics of the population of the area in which the individual (under study) lives rather than their own circumstances; or

(e) indicated by the results of some other study, which may have been based on a measure reflecting utilisation (leading to the potential for circularity in argument).

In practice, researchers who have attempted to adjust for need have tended to use a definition relating to the ill health of the individual, since information on this is more likely to be available than a measure of an individual's capacity to benefit from treatment. In such studies, depending on the data used in analysis, either assumptions (b) or (d) tend to be made, again mainly for practical reasons (discussed further below).

2.2.3 Measuring need

As noted above, the need for health care in an individual can be related to the level of ill health and/or the capacity to benefit from treatment. In small area analyses, of the kind to be conducted in this thesis, aggregate datasets are used to investigate variations in hospitalisation rates. What data pertaining to need might be available to aid such analyses?

The main dataset available on hospitalisation in the UK NHS is the 'Hospital Episode Statistics' (HES) dataset. When an individual is hospitalised as an inpatient, a number of items of information are collected routinely. However information on the *level of ill health* or severity of illness is not directly recorded. For example, for each admission the main diagnosis (and up to 6 other diagnoses) are recorded, as are the main (usually surgical) procedures carried out. The recording of co-morbidities may indicate the level of ill health of the patient, but in the UK NHS co-morbidities are often not recorded as secondary diagnoses on HES data (a finding reported in chapter 5).

However, a large number of factors are known to influence the level of health in an individual (11). The HES dataset includes some information on these, such as age, sex, and more recently some limited information on ethnicity, but not on others, such as socioeconomic status or a functional measure of health status. Hospital admission rates can therefore be stratified or adjusted for age and sex but data are not good enough to do this for other potential need factors such as health status, socioeconomic circumstances or ethnicity.

On the other hand, routinely collected data on hospital admission do include the postcode of residence of the person admitted. Hospitalisation rates can therefore be calculated by small area and the characteristics of the area (using data from other sources) used to indicate relative need. The main types of information available at small area level include:

(a) self-reported health status (a near 100% sample of the population, using data from the 1991 Census);

(b) socioeconomic deprivation (a near 100% sample of the population, from the Census);

(c) mortality rates (a near 100% sample, from the Office for National Statistics).

Data of all three kinds are usually available to researchers aggregated on an area-level basis, rather than by individual. Clearly the problems of ecological fallacy arise when ascribing rates of admission for individuals to what can be called *area-aggregated individual-level* data, since the individuals hospitalised may not be typical of residents in their area (12).

Each of the three kinds of data is discussed briefly below.

(a) Self-reported illness

Large scale national population surveys such as the General Household Survey and the Health Survey for England (HSE) do contain questions on self-reported health status, and in the HSE these questions are combined with measurements of risk factors such as blood pressure and cholesterol levels. However these surveys include only a sample of the population, and the data are not available by small area.

Data on the prevalence of self-reported illness across a sample of the population large enough to yield adequate data for each 'small area' (enumeration district or electoral ward) in England, can be obtained from only one source at present, the Census. In 1991, for the first time the Census (of all persons in all households in England) contained the following question on self-reported limiting long-term illness : 'does the person have any long-term illness, health problem or handicap which limits his/her daily activities or the work he/she can do?'(13). The advantage of this measure is that it is the only item of data on the health status of the population that is routinely available at small area level. The measure typically used in small area analysis is the age-sex standardised rate of limiting long term illness by area, known as the standardised illness ratio (SIR). The main drawbacks of the measure are (i) that self-reported health status is confounded by the expectations of the reporter, (ii) and that it is not specific to any particular disease or condition, and so gives very little information about the potential to benefit from health care.

(b) Socioeconomic deprivation

Because information at small area level on limiting long term illness from the Census has only been available since the mid 1990's, and because of the potential biases arising from self-reporting of health status, researchers have often used small area-based measures of socioeconomic deprivation as a proxy measure for 'need' for health care.

Socioeconomic deprivation is partly an 'individual' concept and partly a 'community' concept. Factors relating to an *individual* can contribute to socioeconomic status, for example type of employment, level of educational attainment, type of housing lived in, access to a car, or age - data on these variables are available from the 1991 census, aggregated by small area. '*Community*' factors include material deprivation, quality of local housing, availability of key facilities, and general levels of unemployment – information on which are also available from the census. Both 'individual' and 'community' socioeconomic factors have been shown to influence health, although there is debate as how and their relative importance (11)(14).

There is no single definition of a 'deprived area'. In the past researchers have used a number of indicators, usually obtained from the census, to assess area deprivation. The indicators are based on 'objective' socioeconomic criteria, for example level of unemployment, housing tenure, proportion of lone-parent households, which can be used singly or combined to form a composite measure, for example the Townsend (15), the Carstairs (16), the Jarman (17) and the Dept. of Environment (18), indices. The first three were developed specifically for use in the context of health care services, in particular for resource allocation and planning purposes.

The table below shows the elements of the main composite indicators used in the UK.

Table 1

Elements of some deprivation indices

Element	**Index**			
	Carstairs	**Jarman (UPA)**	**Townsend**	**Department of the Environment**
Unemployment	x	x	x	x
No car	x		x	
Low Social Class	x			
– Unskilled		x		
Overcrowding	x	x	x	x
Not owner-occupied			x	
Lacking amenities				x
Single parent		x		x
Aged under 5		x		
Lone pensioners		x		x
1-year immigrants		x		
Ethnic minorities		x		x
Vacant dwellings				x
Level and access (old)				x
Level and access (<5)				x
Permanent sickness				x
Large households				x

Source: adapted from Morris R, Carstairs V. Which deprivation? A comparison of selected deprivation indexes. Journal of Public Health Medicine 1991;13: 318-26

The table shows that a variety of variables have been included in each respective indicator.

The Carstairs and Townsend indicators are most similar with three out of four variables in common.

Two key questions are, how were the variables that comprise each index selected, and how is each variable 'weighted' relative to the others and why?

For the three indicators that were developed specifically for use in planning health services, the variables were initially selected according to whether they seemed likely to be associated with material disadvantage and ill health. Of these, for the Carstairs and Townsend indices, the variables finally selected were those most strongly correlated with the measures of ill health (levels of mortality or morbidity). For the Jarman index, the variables selected were those thought to be most associated with higher workload for general practitioners.

On the weighting of each variable within each index, in each index slightly different statistical methods are used. In the Carstairs score, the 4 variables are standardised but unweighted. In the Townsend score, the 4 variables are also standardised and unweighted, but the natural logarithm of two of the variables (unemployment and overcrowding) is used. For the Jarman score, the 8 variables are standardised, then transformed into their natural logarithm, and then each given a weighting determined from a national survey of general practitioners (which aimed to identify the relative pressure on GP's workloads from each of the variables) (17).

Which index, if any, is most suitable for the investigation proposed here? There could be two main criteria for suitability: first that the deprivation indicator includes factors that affect the 'need' for health care over and above the factors represented by SIR and SMR; second, that the deprivation indicator is a measure of social exclusion which may affect access to health care.

For these two criteria, most research has concentrated on how far different deprivation indicators are associated with 'need' for health care. Usually the research has investigated the level of correlation between deprivation measures and ill health (rather than capacity to benefit from care). For example, there is evidence from one recent study that the level of health in a population (health status as measured using the SF-36 questionnaire) is more highly correlated with the Townsend index than the Jarman index (the Carstairs index was not investigated), and particularly highly correlated with two socioeconomic variables – housing tenure and car ownership (19). Other work has measured the correlation of a range of 'health' variables (including SMRs, whether classified as 'permanently sick') with each index and found that the correlation coefficients were strongest for those variables highly associated with the Carstairs index (no car, unemployment, overcrowding, and social class measures (20). The authors concluded that, of the 5 most readily available indicators, the Carstairs and Townsend indices were 'best buys' to use when investigating variations in health. Certainly all the indicators shown above have been shown to be highly correlated (20)(21), and all four have been commonly used in small area analyses in the UK. It is not clear from the available research whether the same levels of socioeconomic deprivation in different locations are correlated with the same level of 'illness' in those locations.

Unfortunately less research has been undertaken to investigate how far various measures of area deprivation really do measure the extent of social exclusion from health care.

(c) Mortality

Information on the cause of, and age and address at, death is available from death certificates that are completed for every death in the UK. The data are collated by the Office for National Statistics and are available at small area level, typically in the form of age and sex adjusted rates, using indirect standardisation to produce the standardised mortality ratio or SMR.

The advantages of using the SMR as an indicator of need are that it is available at small area level, and mortality for specific conditions can be identified, although typically in small area analyses, 'all cause' SMR has been used. The main drawback is that the relationship of mortality to illness levels is uncertain, as is the relationship with potential to benefit from health care. Both of these relationships may be tenuous for some conditions (eg chronic conditions, many of which may be 'ambulatory care sensitive').

Researchers have noted these drawbacks, in particular that two of the three indicators described above do not give useful information about the 'need' for care for specific conditions, such as ACS conditions. A few small area analysts have carried out community surveys to estimate the prevalence of specific diseases under investigation. For example, in a study of variations in hospitalisations for 5 ACS conditions in California Bindman *et al* (22) estimated the prevalence of each of these conditions in the geographical area under study using information from a telephone survey of residents. The results were validated against data obtained from a national prevalence survey. In a multivariate analysis, prevalence of illness was the second most influential variable influencing hospitalisation after access to care as perceived by residents.

In Sheffield in the UK, Payne and Saul analysed hospitalisation rates by electoral ward for coronary angiography, angioplasty or coronary artery bypass graft, according to 'need', as indicated by the prevalence of angina per head of population as ascertained by a community survey (23). They found that rates in the most deprived areas were half those in the least deprived.

Chaturvedi and colleagues used GP consultation rates for those conditions as a proxy indicator of 'need' (24). They found a marked positive association between GP consultation and hospitalisation rates for selected conditions (varicose veins) but not for others (including hernia, gallstones, and hip operations for osteo-arthritis). However, the level of GP consultations was also likely to be influenced by factors other than need such as supply and accessibility, and the study was not able to take into account other factors such as the social class, or deprivation of area of residence, of patients.

In conclusion, all three commonly used measures of 'need' discussed above are problematic in some way. In particular, none addresses the issue of capacity to benefit from health care. Nevertheless, these three are the main measures available at small area level. And since it is highly debatable as to which is the better indicator of need, often in small area analyses in the UK, all three types have been used.

2.3 Access to health care

Section outline
2.3.1 Access and use
2.3.2 Some ways of thinking about access
(a) Aday and Anderson's model
(b) multiple dimensions
(c) multiple levels
(d) 'perceived' and 'in-system' access and outcomes

2.3.1 Access and use

'Access' is sometimes taken to mean *opportunity to use* health care (25). But some researchers and policy-makers often use the term access to mean *utilisation* of care: access is not measured directly but inferred from scrutiny of utilisation patterns. In the literature there has been debate over whether in principle it is best to investigate equity of the 'opportunity to use' health care or 'actual use' (26)(27)(28)(29). Mooney *et al* favour measuring the 'opportunity to use health services' or the costs to the individual of utilisation (25). They argue that to measure utilisation alone ignores the preferences and choices of individuals seeking treatment – a point reinforced by Le Grand (30)(31)(32). Culyer *et al* favour measuring actual utilisation arguing that if the poor have the same opportunity to use care as the non-poor but have a lower take-up of services, then lack of use rather than opportunity would be the major concern of policy-makers (28). They argue that utilisation is an important indicator of 'realised' access and that it is no accident that use and access have been confused for so long.

Various definitions of access that have been put forward also favour taking the utilisation of health care as the measure:

'The proof of access is in the use of services, not simply the presence of a facility' (33)

'The timely use of personal health services to achieve the best possible outcomes' (34)

In practice, most researchers investigating access using quantitative methods have had to rely on utilisation data, partly because the data are easily available. So while 'equal access for equal need' is the more favoured definition of equity in health care, in research 'equal use for equal need' has been used more.

2.3.2 Some ways of thinking about access

(a) Aday and Andersen's Model

Lu Ann Aday and Ronald Andersen and colleagues in the 1970's (35)(36) developed a model to help identify and classify simple and measurable indicators which might reflect the access to, and use of, health care (see figure 1 below).

The model reflects the particular definition of access that at least one of the authors espouse:

'Those dimensions which describe the potential or actual entry of a given population group to the health care delivery system' (36).

The model can essentially be divided into two parts: one (on the left of the figure) containing measures that reflect the potential or probable access of an individual to health care; the other (on the right) containing measures of 'realised' or actual access.

To the left, factors reflecting and influencing potential access are divided into characteristics of *individuals*, of the *community or area* and of the *health care delivery system* (availability). Individual and community factors are grouped according to whether they *predispose* an individual to seeking care, *enable* an individual to seek care, or reflect the *need* of the individual to receive care. As shown, some factors may be influential both at the individual and community level (36). To the right of the figure, features of realised access include not only levels of utilisation of care but also, for example, of satisfaction. Andersen and Aday's early model has been used and developed further by other researchers (37)(38).

Figure 1 **Dimensions of access to medical care and their indicators***

Potential access		Realised access	
Individual	**System (area/community)**	**Objective**	**Subjective (satisfaction)**
Predisposing	Availability	Use	Convenience
Aged 6 or less	Drs/population	Preventive exam	Travel time
Aged 65 or over	Beds/population	Dr visits	Waiting time
Sex	Dentists/population	Hospital admissions	Visit cost
Race		Dental visits	
Education	Area/community Characteristics	Use relative to need	Provider behaviour
			Courtesy of staff
Enabling	*Predisposing*	Symptoms response	Quality of care
Financing	% aged 65 or above	Use/ disability	
Income		Dental want	
Health insurance	*Enabling*		
Visit cost	% below poverty		
	Region		
Organisation	Rural residence		
Particular provider	Central city residence		
Specialty of provider			
Travel time	*Need*		
Prior appointment	Infant mortality		
Waiting time			
Time with Dr			
Need			
Perceived health			
Dental symptoms			
Disability days**			

* Adapted from Figure 1 in Anderson RM, McCutcheon A, Aday LA, Chiu GY, Bell R. Exploring the dimensions of access to medical care. Health Services Research 1983;18(1):49-74.
** The number of days of self-reported disability

As Andersen notes, equity of access to care is implied if the predominant factors influencing utilisation are *need* for care or individual demographic factors such as age (reflecting need), and inequity is implied if *predisposing* or *enabling* factors determine use rather than need (38). Thus a key task of research into access is to try to investigate the respective influence of various predisposing or enabling factors and 'need' for health care.

(b) Multiple dimensions

Aday and Andersen's model implies that access to health care is a *multi-dimensional* concept. The dimensions of factors that enable and predispose individuals or communities to access health care include:

- financial (for example income or health insurance status);
- geographical (for example by distance to health care facilities, available transport);
- educational (for example access influenced by educational attainment, social class, understanding of illness and treatment, previous experience);
- cultural (for example race or language health beliefs);
- gender;
- generational (for example age);
- technological (for example the ability to use communications technology to access health care).

These factors have also been noted by other writers on access, although they have been categorised slightly differently (for example Penchansky &Thomas (39)). Many of the factors listed above are known to have overlapping effects (for example income, area of residence and ethnicity) and they may also influence utilisation of health care in ways other than through access, for example by influencing the need for care. The effect of each factor on utilisation is likely to be difficult to identify separately. The direction of any causal relationship between factors may also be complex (for example a high supply of health service facilities in a community may result in higher levels of use, or vice versa) and cannot be inferred from cross-sectional studies.

(c) Multiple levels

The model also illustrates that access is a *multi-level* concept - that factors influencing access can operate at different levels, such as poverty influencing the individual directly (such as lack of access to a car) and through the community (such as poor public transport).

(d) 'Perceived' and 'in-system' access, and outcomes

It is worth noting that there are at least three dimensions of access (and their measurable indicators) that are not made explicit in the Anderson and Aday model.

First, *perceived* barriers to care may have greater effects than actual barriers (22)(40). Second, it is necessary to distinguish between access to care *once the patient is actually in the health care system* or 'in-system access' (for example, access to care within the GP surgery, such as to a prescription or referral to an outpatient clinic) and access to the *first point of contact* or entry. 'Care' in this sense includes clinical care and 'interpersonal' care – the interaction of health care professionals and their users and carers or 'the management of the social and psychological interaction between client and practitioner' (41). Third, and particularly relevant to this thesis, is the concept of access to timely, effective and appropriate care (care that produces *better clinical outcomes* for that person) rather than just to any form of care. This implies the need to take outcomes and the quality of care into consideration, not just access to, or use of, care.

As noted in chapter 1, in this thesis, hospitalisation rates for ACS conditions will be used as a negative 'downstream' indicator of access to upstream 'timely and effective' ambulatory care. Hospitalisation will thus be an indirect indicator of the quality of ambulatory care, the implication being that some hospital admissions are likely to be avoidable if good quality ambulatory care 'upstream' had been accessible. Section 2.4 below explores these concepts further.

2.4 Avoidable 'downstream' events as indicators of access to, and quality of, health services

Section outline

2.4.1 The concept of avoidable events

The concept of access to health services builds on the idea that the *quality* of care provided is important (for example the timeliness with which it is provided, and how effective it is in improving health outcomes) (34).

The pathway of an individual through a health care system may be complicated, making it quite difficult to assess which type of 'upstream' care influenced which type of 'downstream' avoidable and negative events. However in the literature there seem to be two main areas of focus:

(a) the quality of *ambulatory care* (upstream) and its effect on *hospital admission* (downstream potentially avoidable event);
(b) the quality of *ambulatory and/or inpatient(hospital) care* (upstream) and its effect on subsequent *mortality* (downstream potentially avoidable event).

Billings' work, outlined in the introduction (1), used hospital utilisation for 'ACS' conditions as a proxy *negative* indicator of access to, and quality of, ambulatory care (point (a)). Others have conducted similar investigations (see below), but work with this focus has been relatively uncommon. A few have challenged the idea that good quality primary care might result in fewer 'downstream' admissions. For example a recent multi-centre randomised controlled trial in the US suggested that improved primary care was associated with *increased* hospitalisation (42). However this study was criticised because care given to intervention group was not primary care but intensive specialist care, patients were severely ill with end stage chronic disease, and continuity of care was absent (43)(44).

There has been much more analysis of the effect of 'upstream' care on mortality (point (b)). For example, in the UK, as in many other countries, individual 'sentinel' cases or events are routinely investigated to determine whether care was lacking in cases of peri-operative and maternal deaths (45)(46)(47).

Less common and more controversial has been the analysis of variations in *rates* of events to indicate deficiencies in quality or access. This approach was used by Rutstein and colleagues in the 1970's, who, in a team called the Working Group on Preventable and Manageable Diseases, developed a method of measuring quality of care that counted cases of unnecessary disease and disability and unnecessary or untimely deaths (48)(49). The working group identified three groups of conditions:

- *single index* (or sentinel) cases (where even one case of disease disability or death would indicate a problem);
- *'rates-linked'* conditions (where critical increases in rates of disease or death could serve as indices of the quality of care; and
- *medico-social conditions* (such as homicides, alcoholism and drug dependence - categories "requiring further definition").

For each group a list of diagnoses and conditions were defined. The working group suggested that a failure of lifestyles, medical care, public health and social environmental factors (similar to Aday and Andersen's 'individual', 'community' and 'health delivery system' factors noted earlier) could contribute to critical increases, for example, in the rates-linked conditions and would serve as a 'warning signal' about the quality of care.

The conditions drawn up by the Working Group created a lot of interest in the early to mid-1980's. Most of the resulting investigation focused on avoidable deaths rather than admissions, and 'rates-linked' conditions rather than single index cases in which a failure of quality of medical care was often difficult to prove (50).

In the US researchers continued to analyse 'avoidable' mortality rates and hospitalisation rates using Rutstein's 'rates-linked' conditions, although the analyses were frequently conducted across social and ethnic groups rather than geographical areas. Higher rates of avoidable hospitalisation were found among disadvantaged groups (51)(52).

In the UK, in 1983 Charlton *et al* found considerable variations in standardised mortality ratios (SMRs) for a subset of conditions on Rutstein's list across geographical areas across England and Wales, after adjusting for socioeconomic factors (53). Other studies found similar variations even after adjusting for morbidity (as measured by hospitalisation or disease registration)(54). Maps showing avoidable death 'hot spots' in the UK were produced and a link between the level of the SMRs and the quality of health care was suggested (55). Some argued that this link had not been proven because of the probable long lag time between medical care and death, and because of the multitude of other factors which could affect mortality apart from the quality of health care received (56). Others had previously found that socio-demographic factors were far more influential than health service characteristics on the mortality rates observed (57).

But since many of Rutstein's 'rates-linked' conditions were relatively uncommon (so that large geographical areas were often required so as to include enough events to demonstrate statistically significant differences between areas) and because of the difficulty of linking cause (the quality of 'upstream' medical care) to effect (the rates of 'downstream' events observed), interest in avoidable mortality in the UK waned in the late 1980's. A review of the literature on avoidable mortality concluded that in-depth studies at individual level were more likely to produce information about factors relating to the quality of health services than studies of aggregate data (58), although other authors continue to argue the merits of the latter (59).

Readmission rates to hospital (within 28 days of discharge) have also been examined in a number of studies as a 'downstream' outcome measure of the quality of 'upstream' hospital, and to some extent ambulatory, care after discharge from hospital. But in the UK, one in-depth analysis of a sample of readmissions showed that less than half were in fact avoidable (60), and the author suggested that if readmissions were used as an indicator, only those that were avoidable should be counted (61). Others have come to similar conclusions (62)(63). This suggests that if rates of avoidable events are to be used as an indicator, then there must be very careful definition and identification of what is an avoidable event, in advance of any analysis.

2.4.2 Identifying potentially avoidable admissions

Crucial to the work outlined above has been the identification of a valid list of conditions for which hospitalisation is likely to indicate a problem of the quality of, or access to, 'upstream' ambulatory care. In studying rates of admissions or individual 'sentinel' events, researchers have usually identified in advance a list of conditions for which admission or death could indicate avoidable morbidity or mortality.

For example. Rutstein and colleagues selected conditions on the assumption that *'if everything had gone well, they would have been prevented or managed, to avoid unnecessary disease, disability or death'* (48). The Working Group collaborated with several major medical institutions in the US, such as the Centers for Disease Control and the Veterans Administration, and consulted experts widely.

More recently the few groups of researchers investigating rates of hospitalisation for ACS conditions have developed their own lists of conditions. Billings *et al* analysed hospitalisation rates for three groups of conditions (1). The first group were 'ambulatory care sensitive' (or ACS) conditions:

'diagnoses for which timely and effective ambulatory care can to help reduce the risk of hospitalization either by preventing the onset of the illness or condition, controlling an acute episodic illness or condition or managing a chronic disease or condition'

The second were 'marker' conditions:

'diagnoses for which the provision of timely and effective outpatient (ambulatory) care is likely to have little impact on the need for hospital admission and where there is substantial agreement amongst practitioners on the clinical criteria for admission'.

The third were 'referral sensitive' or 'discretionary' surgeries:

'high cost/high technology surgical procedures for which impediments to access or referral to specialty care may reduce the chances of having the surgery'

An advisory panel of physicians (six internists and paediatricians) drew up a list of ICD-9 CM codes (International Classification of Diseases – 9^{th} revision, Clinically Modified codes) for each group using a modified Delphi technique, specific details of which have not been published. The 'ambulatory care sensitive' and 'marker' conditions selected are set out in table 2 below, having converted the ICD-9CM codes to ICD-9 codes used in the UK. Where the panel thought that conditions were ACS or marker under specific circumstances, for example in specific age groups, this is indicated in the table.

Table 2 **Ambulatory care sensitive (ACS) and marker conditions and ICD-9 codes*, selected by Billings *et al***

ACS Conditions	ICD-9 codes
Congenital syphilis	90, 90.1, 90.2, 90.3, 90.4, 90.5, 90.6, 90.7, 90.9**
Whooping cough	33, 33.1, 33.8, 33.9
Rheumatic fever (without heart involvement)	390
Rheumatic fever (with heart involvement)	391,391.1, 391.2, 391.8, 391.9
Tetanus	37
Acute poliomyelitis	45, 45.1,45.2,45.9
Bacterial meningitis	320***
Epilepsy	345, 345.1,345.2,345.3,345.4,345.5,345.6,345.7,345.8,345.9
Convulsions	780.3
Suppurative and unspecified otitis media	382, 382.1, 382.3, 382.4, 382.9****
Acute pharyngitis	462
Acute tonsillitis	463
Acute respiratory infections	465, 465.8, 465.9
Chronic pharyngitis	472.1
Pulmonary tuberculosis (TB)	11,11.1,11.2,11.3,11.4,11.5,11.6,11.7,11.8,11.9
Other respiratory TB	12,12.1,12.2,12.3,12.8
TB of meninges and central nervous system	13,13.1,13.8,13.9
TB on intestines, peritoneum or mesenteric glands	14
TB of bones and joints	15,15.1,15.2,15.7,15.8,15.9
TB of genitourinary system	16,16.1,16.2,16.3,16.4,16.9
TB of other organs	17,17.1,17.2,17.3,17.4,17.5,17.6,17.7,17.8
Miliary TB	18,18.8,18.9
Chronic bronchitis	491,491.1,491.2,491.8,491.9
Emphysema	492
Bronchiectasis	494
Chronic obstructive airways disease	496
Acute bronchitis and bronchiolitis	466,466.0,466.1^
Pneumococcal pneumonia	481

Table 2 Continued

ACS Conditions	ICD-9 codes
Other bacterial pneumonia	482.2,482.3,482.9^^
Pneumonia due to other specified organism	483
Bronchopneumonia (organism unspecified)	485
Pneumonia (organism unspecified)	486
Asthma	493,493.1.493.9
Heart failure (left)	428,428.1,428.9
Hypertensive heart disease	402,402.1,402.9
Acute oedema of lung	518.4
Hypertension	401,401.9
Other forms of ischaemic heart disease	411^^^
Angina pectoris	413^^^
Cellulitis (finger or toe)	681,681.0,681.1,681.9^^^^
Other cellulitis or abscess	682,682.1,682.2,682.3,682.4,682.5,682.6,682.7,682.8,682.9^^^^
Acute lymphadenitis	683
Other local infections of skin or subcutaneous tissue	686,686.1, 686.8, 686.9
Diabetes mellitus	250,250.1,250.2,250.7,250.9
Hypoglycaemia	251.2
Other non-infective gastroenteritis and colitis	558
Infections of kidney	590,590.1,590.2,590.3,590.8,590.9
Other disorders of urethra or urinary tract	599.599.9
Volume depletion	276.5
Iron deficiency anaemia	280~
Kwashiorkor	260
Nutritional marasmus	261
Vitamin D deficiency	268,268.1
Lack of expected normal physiological development	783.4**
Pelvic inflammatory disease	614,614.1,614.2,614.3,614.4,614.5,614.6,614.7,614.8,614.9

Marker Conditions	ICD-9CM codes
Appendicitis	540,540.0,540.1,540.9~~, 541~~, 542~~
Acute myocardial infarction	410~~~
Intestinal obstruction	560,560.8,560.9
Fractured neck of femur	820,820.0,820.1,820.2,820.3,820.8,820.9~~~~

* ICD-9 codes *International Classification of Diseases, Ninth Revision.*
** all codes as applied to those aged under 1 year
*** in those aged 1-5 years
**** all codes excluding cases with procedures D15, D15.1 or D15.2
^all codes only with a secondary diagnosis of 492,494,496
^^ all codes excluding those in patients aged under 2 months and those with a sceondary diagnosis of 282.6
^^^ excluding cases with a surgical procedure
^^^^ excluding cases with a surgical procedure except S47, S47.1-S47.9
~ in those aged under 5 years
~~ all codes only with surgical procedures H01.1, H01.2, H01.3, H01.8, H01.9, H02.9
~~~ only in cases with an inpatient length of stay >5 days or who died
~~~~ in those aged <1 or >45 years

Weissman *et al* in New Hampshire used three main criteria for selecting conditions as an indicator of whether admission to hospital could represent shortcomings of ambulatory care treatment (64). The criteria were: clinical consensus about avoidability of admission in persons aged under 65 years of age; importance of the clinical problem; and whether or not the conditions were clearly coded on hospital discharge data. The resulting list of 12 conditions, mostly a subset of conditions selected by Billings *et al*, is shown in table 3 below.

Table 3 **Avoidable hospital admissions and ICD-9CM * codes, selected by Weissman *et al***

Avoidable hospital conditions	ICD-9CM* codes
Ruptured appendix	540.0, 540.1
Asthma	493
Cellulitis	681, 682
Congestive heart failure	428, 402.01, 402.11, 402.91
Diabetes	250.1, 250.2, 250.3, 251.0
Gangrene	785.4
Hypokalaemia	276.8
Immunizable conditions	032, 033, 037, 072, 045, 055
Malignant hypertension	401.0, 402.0, 403.0, 404.0, 405.0, 437.2
Pneumonia	481, 482, 483, 485, 486
Pyelonephritis	590.0, 590.1, 590.8
Perforated or bleeding ulcer	531.0, 531.2, 531.4, 531.6, 532.0, 532.2, 532.4, 532.6, 533.0, 533.1, 533.2, 533.4, 533.5, 533.6

* ICD-9 CM indicates *International Classification of Diseases, Ninth Revision, Clinical Modification*. ICD-9 CM codes were used in the USA in the 1990's, whereas ICD-9 codes (un-clinically modified) were used in this period the UK.

Bindman and colleagues in California selected five ACS conditions *'using the opinions of clinicians'* : asthma, chronic obstructive pulmonary disease, congestive heart failure, diabetes, and hypertension (22). Again many of these were a subset of conditions identified by Billings (1).

Solberg and colleagues in Minnesota developed a list of 15 conditions according to four criteria (65):

- clarity of case definition and coding;

- case frequency high enough (at least 1 admission per 10 000) to warrant the development of review criteria;
- broad coverage of age, gender and care types;
- perceived likelihood that the hospital admission would have occurred either at an earlier stage of the disease or not at all if the quality of ambulatory care had been good.

The indicator conditions were selected by representatives from three health maintenance organisations 'by group consensus'. More specific details were not published, neither were the specific codes. The conditions are shown in table 4.

Table 4 Indicator conditions selected by Solberg *et al* (65)

Avoidable conditions
Diabetic acidosis
Ruptured appendicitis
Gangrene of extremity
Hypokalaemia
Pulmonary embolism / infarction
Cellulitis
Peptic ulcer with perforation, bleeding, or obstruction
Transient ischaemic attack or cerebrovascular accident under aged 65 (resulting from hypertensive crisis)
Primary breast cancer – radical surgery
Drug toxicity (drug overdose/toxicity, bleeding resulting from excess anticoagulant therapy)
Endometrial cancer (as an extension of cervical cancer)
Asthma
Premature birth
Ectopic pregnancy
Toxaemia of pregnancy

Other US researchers investigating rates of preventable hospitalisation have used the lists of conditions (or a subset) developed by the researchers already named (3)(66)(67)(68).

No such list of 'preventable hospitalisations' has been developed systematically in the UK. However there has been some recent work in which admission rates for a few conditions thought to be manageable in primary care have been analysed, for example asthma, diabetes and epilepsy (69)(70). Similarly the National Performance Assessment Framework (71), a national set of performance indicators for the NHS published in 1999 and 2000, contains one based on admission rates for diabetes and asthma, purporting to indicate the quality of management of these chronic diseases in primary care.

The methods used by all of the researchers noted above to identify a list of conditions have not been published in detail, but have been based in general on developing consensus among experts, usually clinicians. The studies do not appear to have attempted to:

- gain consensus explicitly on the *degree* of likely avoidability or preventability of admissions for certain conditions (although Billings *et al* did specify the circumstances under which the conditions were likely to be ambulatory care sensitive, as summarised in table 2);
- distinguish between the likely effect of ambulatory care in *preventing the onset of the condition*, or *preventing admission for an existing condition*;
- distinguish between the relative contribution of different types of ambulatory care, such as primary, outpatient or accident and emergency care.

But despite the different criteria and methods used to identify the conditions, there is a fair amount of overlap between those identified by each group of researchers. The table below shows the main ambulatory care sensitive conditions that commonly feature in all lists.

Table 5 Main conditions commonly thought to be ambulatory care sensitive

Condition
Asthma
Diabetes
Pneumonia
Cellulitis
Congestive heart failure
Chronic obstructive airways disease

2.5 A brief overview of the literature on access to, and use of, health services

<u>**Section outline**</u>

2.5.1 Broad types of investigation

2.5.2 Reflections on the literature

- **(a) Multivariate analyses using cross sectional data**
- **(b) Smaller scale and qualitative studies**

2.5.3 Main findings

- **(a) Studies in the US**
- **(b) Studies in the UK**
- **(c) Contrasting the findings for medical and surgical admissions**

2.5.4 Factors found to influence access to and use of health care

- **(a) Age and sex**
- **(b) Indicators of need**
  - **(i) Socioeconomic deprivation**
- **(c) Ethnicity**
- **(d) Patient lifestyle**
- **(e) Perceived access**
- **(f) 'Health System factors**
  - **(i) The hospital itself**
  - **(ii) Levels of supply and access to supply**
    - ***Hospital care***
    - ***Ambulatory care***
  - **(iii) Financing and organisation of care**
    - ***Direct financial incentives***
    - ***Organisation of care***
  - **(iii) Physician practice style**

2.5.5 Summary

2.5.1 Broad types of investigation

The literature on access to health care spans several disciplines, including health services research, medical sociology, policy analysis, health economics, epidemiology, geography, and operational research. In many studies the original aim was not to investigate access at all but some other issue such as how to control health care costs, or the doctor-patient relationship. Nevertheless the results shed some light on the question of access to, and use of, care. There is a very large amount of literature in this area and most studies have been conducted in North America. This section simply gives an overview of the UK and North American literature, examines the broad types of investigation that have been carried out, and identifies the main factors found to influence access to and use of health care.

Broadly, the research can be divided into two main types: large scale multivariate studies, typically either ecological analyses using aggregate cross-sectional data (72)(73); or smaller scale observational and qualitative studies (74). The focus on this review is mainly on the former, because of the intended analysis in this thesis.

Much of the research has aimed to identify the factors that influence access to and use of care. Figure 2 summarises the main factors that have been investigated; the list shown is not exhaustive. The figure looks similar to the Andersen/Aday model (figure 1) shown earlier, except that only utilisation of care is listed as a measure of realised access, since utilisation (hospitalisation) is the indicator of interest in this thesis.

Figure 2 **The main factors that have been investigated as having influence in relation to access to, and use of, care**

Explanatory variables	Explanatory and utilisation variables	Utilisation variables
Column (a)	Column (b)	Column (c)

Area A

'Individual' factors	**Levels of utilisation**	**Levels of utilisation**
(a) self-reported health status	- primary care	- inpatient care
(b) whether classified as 'permanently sick'	- community health services	
(c) age/sex	- accident and emergency care	
(d) income, occupation	- outpatient care	
(e) access to a car		
(f) housing tenure		
(g) education		
(h) ethnicity		
(i) lifestyle		
(j) possession of health insurance		

Area-level aggregated data of 'individual' factors
(especially (a) to (h))

'Community' factors
(k) physical environment (eg pollution)
(l) availability of public transport

'Health System' factors
(m) supply of facilities (eg staff, beds)
(n) distance to facilities
(o) quality of facilities
(p) practice style of clinical staff
(q) funding of health service facilities
(r) organisation of facilities

Area B

Columns (b) and (c) in figure 2 list some of the factors used as indicators of realised access. Essentially these are measures of utilisation (mainly numbers or rates of contacts) in the ambulatory ((column (b)) or inpatient ((column (c)) setting. These factors are frequently used as *dependent* variables in small area analyses.

Column (a) groups the main types of variables that have been investigated to see whether they are associated with utilisation. They are typically used as *independent* variables in small area analyses. As in Andersen and Aday's model these are divided into 'individual', 'community' and 'health system' factors.

The factors listed under the heading 'individual' include all individual-level data that are available routinely, typically from population surveys such as the General Household Survey (75) and the 4[th] National Survey of Ethnic Minorities (76). As noted above, routinely collected NHS data on hospital admission also include some 'individual' variables such as age and sex.

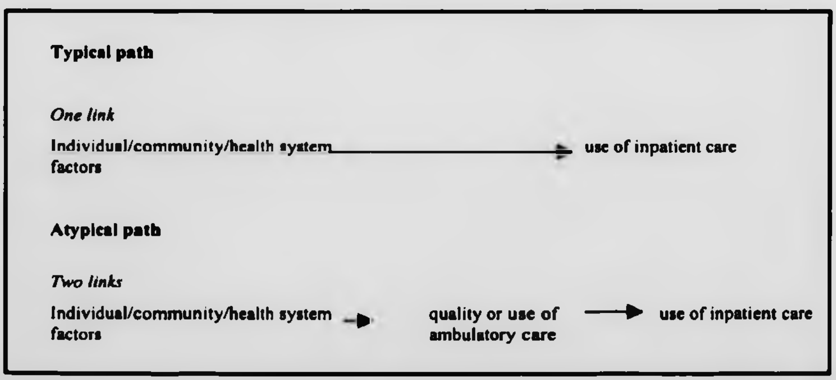
'Area-aggregated individual-level' data include 'individual' factors that have been aggregated by area (typically obtained from the census). 'Community' factors include those that may affect need or access to care over and above individual factors, such as levels of unemployment or access to public transport. 'Health system' variables are available from routine sources and are often expressed by institution (eg numbers of staff) or by area (staff per head of catchment, or area, population). The factors that have been investigated include the supply of facilities and their distance from users, the quality of care provided, how facilities were organised or funded, and the 'clinical practice style' of physicians. These factors have been measured for the varying types of ambulatory as well as inpatient care.

The two main types of investigation using the variables summarised above have been : a) population surveys, which have been able to link *self-reported* utilisation of health care with self-reported data on income and health status in individuals, allowing 'individual use' to be analysed by 'individual need'; and b) ecological studies using health service routine data on the *actual* utilisation of care by individuals. The latter tend to be able to link *individual* use with few individual-level variables (such as age and sex) but more often have used area-aggregated individual-level data and 'community' factors as proxy indicators of need (such as socioeconomic deprivation).

Most of these ecological studies and surveys have measured the influence of variables in column (a) on utilisation variables in column (c), and much less commonly on those in column (b). There has also been a lot of work examining the association between variables *within each column.* More of this has involved variables within column (a) (for example the association between area-level morbidity (as a measure of need) and the supply of health care facilities) than within column (b) (for example the association between use of primary care and use of care in accident and emergency (A&E) departments).

Investigation of the effect of variables in column (b) on column (c) - such as the effect of utilisation of primary care, or A&E care, on subsequent utilisation of hospital care - has been unusual. This may be because most of the studies outlined have been conducted in the US and UK where there has been a relative lack of routine data on utilisation in ambulatory care. The US literature typically contains studies investigating associations across one link, such as between 'individual' or 'community' factors and hospitalisation, rather than across two links, for example the influence of 'individual' or 'community' factors on utilisation of ambulatory care and the influence of use of ambulatory care *and* 'individual' or 'community' factors on subsequent utilisation of hospital inpatient care (see figure 3 below). This type of investigation may increase with the growing emphasis in both the US, and the UK, on managed care, the recognition that family physicians can play a significant 'gate-keeping' role, and as information systems allow integration of data between health care facilities in the acute and ambulatory care sectors.

Figure 3 Pathway of analysis



The sections below offer broad reflections from the literature first using multivariate analyses of cross –sectional data, and then using smaller scale and qualitative methods of investigation.

2.5.2 Broad reflections on the literature

(a) Multivariate analyses using cross-sectional data

Two broad strands of work apparent from the literature are illustrated in figure 2 as Area A and B. Area A includes multivariate analyses that have mainly used data from population surveys. Area B includes multivariate analyses that have mainly used routinely collected health service data on utilisation.

Studies in Area A have tended to use *population survey data* to link information in individuals, for example on self-reported utilisation of health care and self-reported variables listed under 'individual' in column (a). The concern of many researchers in this area has been equity of access to care, and typically rates of utilisation between population groups of interest (such as by race, income, or insurance status) have been compared after some adjustment for need (usually age, sex, self-reported health status and ethnicity) and other factors. Because the geographical location (rather than broad type) of the health services utilised is usually not available from survey data, health system variables such as supply of facilities, distance to, quality or organisation of services available to users have generally not been taken into consideration even though these are known to have important effects on utilisation (77)(72).

Studies in Area B generally include ecological studies *using information that has been routinely collected by health services*, typically hospital discharge data. Typically utilisation rates of hospital (rather than ambulatory) care have been compared between geographical areas or between specific population groups (such as ethnic or, in the US, income group). In these studies 'health system' variables can be taken into account because the location of health care used and the residence of the patient are likely to be known. The 'health system' factors investigated have related more to hospital facilities than ambulatory care, for example the supply of beds, the numbers of doctors per capita working in the area, or (in the

US) the method of funding the facility (for example fee-for-service or prospective payment). There has been much less investigation of the effect of different forms of organisation, or utilisation, of ambulatory care on hospitalisation rates. Generally studies in Area B, in contrast to those in Area A, have used less satisfactory data on 'need' with which to explain variations in utilisation, because researchers have mostly had to rely on 'area-aggregated individual-level' measures.

The concern of many US researchers conducting small area studies (included in Area B) has been on the *appropriateness* of variations in utilisation in view of the higher health care costs in high rate areas, and therefore on *efficiency* over and above equity. In contrast, in the UK small area analysis of hospitalisation rates has mainly been used to investigate the geographical *equity* of allocation of resources within the National Health Service, for example (78).

It was only in the 1990's that increasing numbers of US researchers who were interested in equity and access, rather than efficiency, began to use small area analysis in their enquiries. This may have been prompted by several factors. First was the growing realisation that there were specific conditions for which ambulatory care may have greater potential to reduce the need for hospitalisation. Second was the identification of these conditions - known variously as ACS conditions (1)(22) or 'avoidable hospital conditions' (AHCs) (64) (as outlined earlier). Third was the observation that high hospitalisation rates for these conditions occurred in patients living in low income areas with a lack (in terms of quality and quantity) of primary care. Finally, mapping hospitalisation rates for a group of these conditions by small area allowed presumed difficulties in access to ambulatory care to be pinpointed geographically, thus facilitating the targeting and evaluation of policies to improve access. But as yet only a few studies of this kind have been conducted.

(b) Smaller scale and qualitative studies

Qualitative studies in Area A (figure 2) include those found in the medical sociology literature. Researchers have tried to identify factors, particularly in individual patients and doctors, that influence utilisation of care. Much of this research has tended to be small-scale and qualitative because of the number and complexity of factors involved. For example studies have attempted to examine the effects of individual factors such as health beliefs, illness behaviour, lifestyles, culture, or social support, on patients' decisions to seek care and their actual use of health care (79). Others have examined 'in-system access' - for example the effect of the doctor-patient interaction on access of patients to subsequent hospital care (80)(81).

These studies have demonstrated the complex array of factors that influence use of health care, including how the health system is organised and financed, and psychosocial factors relating to doctors and patients (74). For example Newton *et al*, in a UK study based on interviews with 15 general practitioners, found that no less than 23 factors - both clinical and non-clinical - influenced the treatment received by patients. Non-clinical factors related to personal characteristics of the referring doctor (such as toleration of risk, legal implications), of the patient (such as expectations, social circumstances and ability to assert their views and feelings), the doctor's relationship with the consultant being referred to and the doctor's level of clinical experience (81). It has not been possible to take many of these factors into account in larger scale surveys or ecological research that rely on routinely collected data.

Smaller scale studies in Area B also include prospective or retrospective studies of individual admissions that have attempted to identify factors that have led to hospitalisation. These studies have more often investigated the *appropriateness* of admission for each patient (for example whether a lack of an appropriate and alternative location of care resulted in the admission) rather than the *avoidability* (whether the condition could have been prevented to an extent that admission was not needed), although the two terms are often confused in the literature. Again a complex number of reasons for admission has been described which simply cannot be taken into account in large ecological studies.

There have been a few other types of investigations which do not fit into the pattern described, for example those which have combined actual utilisation data with survey data. For example, in the UK, Carr Hill *et al* combined data from the 4th National Morbidity Survey in General Practice (providing some individual-level data) with information from the 1991 census (providing area-aggregated individual-level data) (82). The 4th National Survey covered 502 493 patients who consulted a GP from September 1991 to August 1992 in one of 60 sample practices in England and Wales – equivalent to a 1% sample of the population. For each face to face consultation, information was recorded which included the reasons for the consultation, as well as key 'individual' factors such as age, sex and socioeconomic circumstances. This way patients' utilisation of GP care and referral to outpatient care ('individual use') could be linked with factors denoting 'individual need'.

The factors found to influence hospitalisation in all these studies may have a different level of influence in different countries, depending on the specific mix of types of reimbursement, incentives, organisation of health care, the health seeking behaviour and expectations and culture of patients or the health care professionals. This is important to note when considering the implications of results from other health systems for the UK.

2.5.3 Main findings

Most of this section will consider studies investigating the influence on hospital utilisation of the different factors listed in columns (a) and (b) in Figure 2. The aim will be to identify the factors that have consistently been found to be influential, and which will thus be important to investigate in this thesis. There will be a particular focus on the findings of small area studies (included in Area B in figure 2) that have investigated admission rates for ACS and marker conditions, although some observational and qualitative studies are also included. Because of the importance of 'need' in relation to hospitalisation, attention will be given to how this has been taken into account in the analyses. Factors in column (a) in figure 2 which have been found to influence the use of ambulatory care (column (b) in figure 2) will also be briefly reviewed, because access to ambulatory care is also likely to influence hospitalisation and the factors influencing access to ambulatory care may be different from those influencing hospital care.

(a) Studies in the US

In the US there has been a great deal of investigation into access to care using aggregate survey data (Area A in figure 2), such as from the National Health Interview Survey.

Poverty, lack of health insurance and non-white ethnicity have long been associated with an overall lower use of all types of health services after adjusting for differences in health status (83)(84)(85). For example, uninsured children with treatable conditions such as asthma have been shown to be less likely to receive care and be at risk of substantial avoidable morbidity (86). The introduction of publicly funded insurance (the Medicaid and Medicare programme) and other public initiatives have been shown to have had a major impact in reducing financial and other barriers to accessing care for the poor over the last twenty years in the US, effectively equalising the use of ambulatory and hospital care between recipients and the privately insured after controlling for need (as indicated by self-reported health status) (83). However recent studies still report inequities in utilisation by income and race (87)(88)(89).

As noted earlier, in general the small area analysis literature from North America (Area B in figure 2) has focused on questions of the cost-effectiveness (efficiency) of variations rather than questions of equity of use of health care. In an extensive review of the North American literature on small area analysis in 1987, Paul Shaheen showed that there had been more studies of admissions for surgical procedures than medical conditions, and that studies had generally not been able to take 'need' into account. 'Supply' of health services was most consistently shown as being the major factor influencing variations in rates of surgical procedures, whereas 'community' and 'individual' factors, such as poverty and health insurance status, appear to exert a stronger influence on the variation in medical admissions (72). But since many of the studies reviewed did not adjust for need, the effect of supply may be over-emphasised. In most small area studies, a large amount of variation remained unexplained, leading some to believe that factors that were not easily quantifiable - such as health beliefs and illness behaviour (74), patient lifestyle choices or the differing practice style of clinicians - may be influential (90).

There has been much less work of this kind in the US to examine variations in utilisation of ambulatory care. One reason is that while survey data are available (the results are referred to above), health service data on utilisation of ambulatory care are less routinely available (91).

(b) Studies in the UK

In line with the objective of the NHS to provide equal access for equal need, there has also been extensive investigation into variations in use of health care based on survey data (Area A in figure 2). Using data from the General Household Survey (GHS), higher rates of inpatient and outpatient care and GP consultations have been found among more socioeconomically deprived groups and most ethnic groups. Because the prevalence of illness is also higher in these groups, many studies have sought to adjust for these differences, although the most appropriate method for doing so is still debated (92)(93)(94)(95)(96)(97). Using GHS data, O'Donnell and Propper showed that use of ambulatory and inpatient care in the UK was more influenced by self-reported health status than any other factor. Their conclusion - that there was no evidence to suggest systematic inequity in use of inpatient care between social or ethnic groups (92) - has been underlined more recently by other similar work (98).

There has also been a considerable amount of analysis of rates of hospital admissions over the past 20 years using routine NHS utilisation data (Area B in figure 2). The most extensive was by researchers at the University of York, in developing a needs-based resource allocation formula for NHS funding (99). One of their studies involved an analysis of the determinants of use of hospital resources between 4 985 small areas (aggregates of electoral wards, or so-called 'synthetic' wards) covering all of England. The key variables tested included indicators of 'need' (mortality, limiting long-standing illness, permanent sickness and low birth weight) and indicators of supply or 'health system' variables (accessibility of NHS hospitals, accessibility of GP services, provision of nursing and residential homes, and accessibility of private hospitals). Of these, the study found that the factors most positively associated with acute episodes of inpatient admission (surgical as well as medical, emergency as well as elective) were all-cause standardised mortality ratio (for those aged under 75 years), limiting long-standing illness (for those under 75 years), the proportion of persons of pensionable age living alone (all 'need' variables), and the levels of access to GP services and to private hospitals ('supply' or 'health system' variables). How these 'access' factors were constructed is briefly discussed later, and in the methods section in chapter 6.

In a review of the literature on variations in hospitalisation rates, Sanders *et al* noted that in the UK surgical admissions had been investigated far more than medical admissions, and again the supply of hospital facilities (usually beds) had a consistently positive influence on the rates (73). However a significant amount of variation remained unexplained, and, as so often in literature reviews on this topic, there was an inadequate discussion as to the extent that 'need' factors were taken into account in the analysis. Conclusions are very difficult to draw from such reviews.

Some researchers have analysed variations in hospitalisation not by area of residence, but by general practice of registration. In one such study, involving 209,136 emergency and elective admissions in London in 1996, Reid found that admission rates between practices (for all, emergency, and elective admissions, respectively) varied twofold and that the differences in admission rates between practices were influenced more by socioeconomic factors (measured at area-level) (these explained 45% of the difference observed) than by health system factors (100) . The latter factors included *'GP practice'* factors - a range of features of the general practices including whether a system of child surveillance was provided, or whether minor surgery was offered - which explained approximately 10% of the variation, and *'hospital factors'* - the specific admitting hospital - which also explained approximately 10%.

As in the US, in the UK there has been much less analysis of variations in use rates of ambulatory care using routine health service data. In England & Wales there is no routinely collected minimum dataset for primary, outpatient or A&E care. The most extensive dataset is the National Morbidity Survey of General Practice (referred to above); otherwise studies have used information from selected individual practices.

Such as it is, the literature shows that GP consultation rates are influenced by factors similar to those for hospital utilisation. Generally there is a positive association with socioeconomic deprivation, morbidity, ethnic minority status and age ('need' factors), and a positive association with the accessibility to health service facilities (as measured by inverse distance) (24)(101)(102)(103)(104)(105)(106)(107)(108)(109)(110). Again these studies have not been able to adjust adequately for need for health care.

One study that did attempt to adjust for need, referred to earlier, combined data from the 4th National Morbidity Survey in General Practice (providing some individual-level data) with information from the 1991 census (providing area-aggregated individual-level data) (82). Characteristics of individual patients (such as age, employment status and whether classed as permanently sick) were much more powerful predictors of consultation rates than area-aggregated data on 'need' from the census, or 'health system' factors (distance from the centre of the enumeration district of residence to the centre of the enumeration district of the general practice). Studies combining data in this way are very rare.

The broad findings suggest slight differences between the US and UK literature in that the UK work generally points to a stronger influence of 'need' factors over and above 'health system' factors on utilisation rates, whereas the reverse is apparently true in the US. However the picture is confused because much of the investigation in the US has focused on variations in admission rates for surgical procedures, whereas in the UK the work has been dominated by researchers at the University of York who have examined variations in admission rates for medical and surgical conditions together. Furthermore, in both countries, studies in which 'need' has been explicitly taken into account in some way in the analysis are relatively uncommon. Since 'need' may be confounded with 'health system' factors, such as supply of hospital beds, it is difficult to tease out their respective influence on the variations.

(c) Contrasting the findings for medical and surgical admissions

One advantage of using routine utilisation data rather than survey data is that analysis of admission rates for medical and surgical conditions, and a range of specific clinical conditions is more likely to be possible. This is important because the extent, and direction, of factors influencing hospitalisation may be different according to the types of conditions studied.

As previously noted, small area studies in general show that hospitalisation rates vary more for medical conditions than surgical (72)(73)(111) and that across a variety of locations studied there has been a pattern of conditions showing high or low variation. Low variation conditions include appendicitis and myocardial infarction (73) and are typically conditions requiring mandatory and immediate treatment (such as those included in the list of marker conditions identified by Billings (1)). High variation conditions include many medical conditions (subsequently identified by other researchers as ACS conditions) such as asthma and diabetes as well as some surgical, typically discretionary, procedures such as hysterectomy (72)(73). Furthermore there appears to be consistency in the pattern of admission rates across locations over time. For surgical procedures this pattern has been dubbed a 'surgical signature' (112), leading to a hypothesis that unexplained variation might be due to the distinctive clinical practice styles of different physicians.

For specific clinical conditions, in the US, small area studies have found that hospitalisation rates for lower income and certain ethnic groups (black and hispanic) are *lower* for some conditions (for example for so-called 'discretionary' procedures for coronary heart disease such as coronary artery bypass grafting, hip/joint replacement (34)(113)(114)), and *higher* for others (medical admissions such as diabetes and its complications (1)(115)(116)) and avoidable injury (117)). Observational studies have also demonstrated higher rates of hospitalisation of lower-income people for asthma (118)(119) and diabetes (120), many of which were classified by Billings and others as ACS. While these studies have not tended to take formally into account differences in underlying levels of disease between income groups, it has been noted in a few studies that variations in admission rates are many times higher than variations in prevalence of the condition (identified from survey data) across income groups (1) (121).

In contrast much less variation by socioeconomic group has been observed for conditions requiring mandatory and immediate treatment such as fractured femur and appendicitis (1)(118).

These findings are confirmed by small area studies of hospitalisation for a range of conditions defined as ambulatory care sensitive (ACS) and 'markers'. In particular in the US a strongly *negative* association has been found between hospitalisation for ACS conditions and income, having health insurance cover, and non-white ethnicity respectively (1)(22)(64)(67)(122) (123). Researchers have concluded that this may be a result of significant access barriers to 'upstream' care - ambulatory care - for low-income and non-white populations in the US. For example, Billings *et al* found that the overall average ratio of standardised admission rates for ACS conditions (in those aged under 65) between high and low income areas was 1: 4.65, the greatest differences (ratio of 1:7 or 1:6) related to admissions for congestive heart failure, hypertension and asthma, and even the lowest ratio was 1:3 (admission for the diagnosis of angina) (34).

In the UK, while an overall positive relationship between hospitalisation and socioeconomic deprivation has been found (73)(99), a negative association has been found for some discretionary procedures (such as coronary artery bypass grafting, hernia, gallstones and dilatation and curettage), although most of the relevant studies have been unable to adjust adequately for other need factors (24)(104)(124).

Variations in hospitalisation rates for a range of mainly medical conditions (identified by others as ACS) have been only recently investigated as such in the UK. Giuffrida and colleagues analysed hospitalisation rates (inpatients and day cases) for several conditions - asthma, diabetes and epilepsy (classified by others as ACS) – across 'small' areas covered by the former NHS Family Health Services Authorities (approximately 300, 000 population) in England, for the period 1989/90 to 1994/5 (69). They found, in a univariate analysis, that there was a significant ($p < 0.01$) strong correlation with socioeconomic deprivation (correlation coefficients between 0.69-0.78), and a similarly significant ($p < 0.01$) strong correlation with supply factors (supply of hospital and primary care facilities) (0.90-0.98). Because of overlapping (confounding) effects between these two variables, in a multivariate analysis the correlation coefficients for each dropped to approximately 0.50. Furthermore they found that socioeconomic factors had a similar sized impact on hospitalisation rates to age and sex.

2.5.4 The factors that have been found to influence access to, and use of, health care.

In the paragraphs below, rather than discuss an exhaustive list of factors that have been shown to influence access and use, only findings for the main factors are summarised.

(a) age and sex

Most studies in the UK and US investigating variations in hospitalisation have compared rates that have been standardised for age and sex, as both those factors have long been shown to have an important influence on the use of inpatient, outpatient, and primary care. For example in both countries hospitalisation rates increase markedly for patients over age 60, and females generally use more health care than males (125). The advantage of standardising for age and sex is that it may be easier then to identify other factors influencing variations in use of health care. The disadvantage is that effects of interest specific to different age groups may be hidden.

For an example of the influence of age, as noted in the introduction, Billings found large differences in hospitalisation rates for a range of ACS conditions between residents of high and low income areas for people in age groups 25-54 years, but much smaller differences in those over 65 years and under 18 years (1)(2). While the rates were not adjusted formally for morbidity, the researchers suggested that these findings may reflect differences in health insurance coverage, and therefore access to care, since children and the elderly are more likely to be covered by public health insurance.

Different age groups may also experience differences in the incidence, prevalence and severity of disease (as has been shown for asthma and wheezing illness (126)(127)), or differences in socioeconomic deprivation (128) or preferences for different types of care.

With regard to gender effects, a number of studies suggest that access to certain types of care by women may be lower than for men, and conclude that this is evidence of gender bias in the behaviour of health care professionals. But in a review of the international literature on the use of *specialist* health care by gender, Raine found that of five major care areas – coronary artery disease, renal transplantation, human immunodeficiency virus and acquired immune deficiency syndrome, mental illness, and other (mainly invasive) procedures – the evidence for gender inequity was mixed and weak (129). Most of the research has focused on coronary artery disease, and no clear gender inequity in investigation and treatment was apparent. However, similar investigation into gender bias in hospitalisations for ambulatory care sensitive conditions has not been conducted.

Nevertheless, the literature suggests that age and sex are important factors influencing use of care, and there may be factors specific to different age and gender groups that influence access to care.

(b) Indicators of need

Three types of 'need' indicator were considered earlier, and all three have been found to be positively associated with hospitalisations for medical and surgical conditions. In the paragraphs below, the focus is on the evidence of the impact of one of the three indicators, socioeconomic deprivation, on access to and use of care. Socioeconomic deprivation is examined more closely here because of the central hypothesis in this thesis that higher hospitalisation rates for ACS conditions would be found in more socioeconomically deprived areas even after adjusting for other 'need' factors.

(i) Socioeconomic deprivation

Quantitative studies using aggregated datasets
Concerning *inpatient care*, in the UK many researchers using survey data have found that, after adjusting for self-reported health status, either there is no consistent evidence of inequity in the utilisation of NHS inpatient care between people in different socioeconomic circumstances, or, if anything, there is a 'pro-poor' bias (92)(130).

It was also noted earlier that researchers conducting small area analyses have found that socioeconomic deprivation is strongly and positively correlated with hospitalisation rates

(72)(99), although researchers have not been able to adjust adequately for other need factors such as prevalence or severity of disease.

In the US, discussed earlier, the positive influence of socioeconomic deprivation on hospitalisation rates can be reversed for specific types of admissions such as 'discretionary' surgeries like coronary artery bypass grafting. In the UK there has also been a focus in investigating hospitalisations by small area for specific conditions and procedures, although such work has tended to be small-scale. Care for patients with coronary artery disease has been the single most investigated topic. In a survey of 180 GP practices in Nottinghamshire between 1993 and 1997, Hippisley-Cox found that rates of hospital admission by practice for coronary angiography and revascularisation techniques were lower, and the length of time waiting for admission higher, in practices serving more deprived populations, with presumably greater need (131). In Cheshire, admission rates for cardiothoracic surgery (and for hip and knee replacements) were again found to be lower in less affluent areas (132).

As noted earlier, in Sheffield admission rates for coronary artery revascularisation procedures were lower in more deprived areas after adjusting for need – half the number of revascularisations per head of population with angina (23). In contrast, in Northern and Yorkshire NHS region higher rates of admission for coronary artery bypass grafting (CABG) and percutaneous transluminal arterioplasty (PCTA) were found in more deprived areas, but the authors concluded that the rates were not as high as the underlying standardised mortality ratio (the need indicator selected) for coronary heart disease would suggest it should be (133). Kee *et al* analysed 24 179 admissions of patients with a diagnosis of ischaemic heart disease. Rates of cardiac catheterisation and angiography were 85.5 per 100 000 in non-deprived males compared to 123 per 100 000 in deprived males. However after adjusting for potential confounding factors (such as age), the difference was not found to be statistically significant (134).

As referred to above, Giuffrida and colleagues analysed hospitalisation rates for asthma, diabetes and epilepsy finding that socioeconomic factors had a similar sized impact on hospitalisation rates to age and sex (69).

Concerning **hospital outpatient care**, analysis of General Household Survey data in the UK again suggests, after adjustment for self-reported health status, no systematic inequity in the use of outpatient care by people of different socioeconomic status (92). Small area analysis of use rates for outpatient care using actual utilisation data has generally not been performed in the UK because of a lack of adequate data. With regard to other forms of ambulatory care, such as district nursing and health visiting, and hospital casualty departments, the significant positive influence of socioeconomic deprivation and morbidity has also been demonstrated in the UK using small area analysis (135)(136).

Concerning **primary care**, while the UK NHS offers primary care which is free at the point of use, there is still a cost to the patient (for example travel costs, time off work) which may have a greater deterrent effect in socioeconomically deprived groups. Data from the General Household Survey suggests that people who are socioeconomically deprived tend to consult more often than those who are not, but again (and this is still debated) these differences disappear once there has been adjustment for need in the analysis (92).

Research in the UK on variations in GP consultation rates has tended to focus on variations between population groups (typically categorised by deprivation) within or between general practices rather than small geographical areas. The evidence is more straightforward for some forms of primary preventive care - care for which, in theory, the need in the targeted populations is equal, whether deprived or not. For example, data on the uptake of screening for cervical cancer and childhood immunisations are available by practice, and rates are consistently lower among socioeconomically deprived populations (137)(138)(139)(140)(141).

As noted earlier, research using the MSGP-4 dataset shows a positive relationship between GP consultation rates and socioeconomic deprivation (82). More deprived groups may be consulting for more serious conditions, as suggested by Saxena, who showed that while consultation rates for children were higher in more deprived socioeconomic groups (without adjusting in any way for other need variables), these consultations were more likely to be for intermediate and more serious categories of illness, and less likely for preventive care than less deprived groups (109).

More focused studies

Many observational and qualitative studies have examined in more detail the influence of socioeconomic deprivation on use of health services (38)(142). In the US poverty is a barrier to patients seeking care and a lack of insurance (or having public insurance) deters providers from offering care (143)(144). As a result the low-income and uninsured tend not to have a regular source of care, receive less preventive care, delay seeking care, use less ambulatory care (uninsured persons versus insured), experience poorer health outcomes and use proportionately more A&E and inpatient care for certain conditions (143)(145)(146)(147)(148). However, doctors may lower the clinical threshold of admission for patients in response to non-clinical factors, such as poverty, perceived non- compliance, and lack of social support (149)(150). However vivid these findings are, it has generally not been possible to take them into account in small area analyses using area-aggregated data because information on these factors is not collected routinely either through the census or in health services (74)(142).

In the UK there has also been a wealth of small scale studies analysing the effect of socioeconomic factors on access to, and use of, health care. These studies show persistent barriers to access resulting from socioeconomic deprivation (151)(152) which can result in untimely and inadequate treatment. For example, the supply and quality of primary care in deprived areas in inner cities, particularly London, has long been known to be worse than in other areas (153)(154). The National Survey of NHS Patients (General Practice) in 1998 (155) showed that a significantly higher percentage of patients in more socioeconomically deprived health authorities put off a visit to the GP because of inconvenient hours. Another study showed that patients from deprived areas were over twice as likely to perceive problems in accessing daytime GP services (156).

There is a large literature on the effect of socioeconomic status of patients on the GP-patient interaction, which may affect access to subsequent inpatient care. In the UK, the more socioeconomically deprived patients have been shown to be given shorter consultations, less advice, more prescriptions, and have a lower likelihood of receiving, or being referred for, a diagnostic test (80), although there is mixed evidence on follow-up visits and subsequent inpatient hospitalisation. Scott suggested that there were three mechanisms by which socioeconomic status could influence GP consultations independent of health status: social distance between GP and patient; health knowledge and beliefs of the patient; and the extent that professional power of the physician can be moderated by patients. A study of 500 consecutive patients in 4 practices in Bedfordshire and Hertfordshire (areas included in the analysis described in chapter 6), reported that general practitioners listened less, examined less, and gave less advice to patients in Social Classes V and IV (manual occupational groups) compared to those in Social Class I and II (professional and managerial occupational groups) (157). Patients in more socioeconomically deprived groups have been shown to experience less continuity of primary care, are less compliant with treatment, and have a poorer quality interaction with professionals (158).

Socioeconomic status may also be associated with different *preferences* of the patient for care, which in turn influence whether or not a patient will be referred (or will refer him/herself) to hospital, and be subsequently hospitalised. For example, Coulter *et al* showed that patients with menstrual disorders who had lower educational achievement tended to prefer surgical treatment (as opposed to more conservative treatment) and that the likelihood of GP referral was related to patient preferences for surgery (159). Also in the UK, Armstrong showed that perceived pressure from patients on the GP to refer led to increased referrals (160). Such pressure is likely be associated with better informed and articulate patients with higher socioeconomic status. It may be that more socioeconomically deprived patients prefer to go to a hospital casualty department for care (given difficulties in accessing primary care), and once there clinicians have been shown to be more inclined to admit socio-economically deprived patients than others with similar illnesses (161).

The influence of socioeconomic deprivation on *GP referral to hospital*, and the way it is mediated, is obviously complex. There are such a large number of factors influencing the decision to refer (81) that teasing out the independent effect of deprivation of the patient is difficult, in particular from the effect of morbidity. Furthermore many studies examining variations in GP referrals to hospital have examined *all* referrals rather than referrals by specialty or by condition. It is possible that socioeconomic deprivation may have a stronger impact on the decision to refer for some conditions than others, analagous to the hypothesis in this thesis that deprivation might have more effect on hospitalisation for ACS than marker conditions. For example, a cross sectional survey of new referrals in Nottinghamshire in 1993 found a strong positive (r-squared = 32%) and significant ($p<0.0001$) association between socioeconomic deprivation (as measured using Jarman scores (17)) and medical referrals, but a much smaller effect on surgical referrals (r-squared - 2.3%, $p<0.04$) (131).

In summary, analysis of information from large-scale surveys suggests that, after adjustment for self-reported health status, inequity in the use of health care between socioeconomic groups has not been consistently demonstrated in the UK NHS. However small area analysis of variations in use for specific conditions (mainly investigations and treatment for coronary heart disease) suggests otherwise. Qualitative research also points to significant barriers to entering the health system, and 'in-system' access, due to a number of complex reasons relating to the individuals seeking care, the communities they live in, and the health system and professionals providing care.

(c) Ethnicity

The Department of Health in England defines an ethnic group as 'a group of people who share characteristics such as language, history, culture, upbringing, religion, nationality, geographical and ancestral origins and place' (162). There is much debate as to what ethnicity actually is, and clearly the definition of an ethnic group, for an individual or for a whole group, may be inconsistent or may change over time. In Britain, a question in the 1991 Census asked respondents to record their ethnic group as being either: white; Black-Caribbean; Black African; Black-Other; Indian; Pakistani; Bangladeshi;Chinese; or Other. On these definitions, the results are shown in the table below.

Table 6 Resident Population by Ethnic Group, Great Britain, 1991

Ethnic Group	Proportion of total population (%)	Proportion born in Britain (%)
White	94.5	95
Black – Caribbean	0.9	54
Black- African	0.4	36
Black – other	0.3	84
Indian	1.5	42
Pakistani	0.9	50
Bangladeshi	0.3	37
Chinese	0.3	28
Other – Asian	0.4	} 44
Other – non Asian	0.5	}

Source: 1991 Census, Local Base Statistics, OPCS Crown Copyright

Ethnicity may important to consider in the context of this thesis. A significant proportion of the population in the area covered (the former North West Thames NHS region) is made up of non-white ethnic groups, and ethnicity may have a key influence on access to, and use of, hospital care. Also the prevalence and severity of illness for ambulatory care sensitive conditions, such as diabetes, may be higher.

However the influence of ethnic group on use of health care is heavily confounded by socioeconomic status and the other 'need' factors discussed above, and most studies have not adequately separated out these effects.

There has been extensive investigation in the US as to the impact of race on variations in hospitalisation rates. Analysis using survey data (eg from the National Health Interview Survey) suggests that non-white ethnicity is associated with an overall lower use of all types of health services (ambulatory and inpatient) after adjusting for differences in health status.

Analysis using routinely collected health service data suggests a negative association between non-white ethnicity and hospitalisation for discretionary procedures (for example investigations and treatment for coronary heart disease), and a positive association with ACS conditions.

In the UK most analyses have used data from population surveys, in particular the General Household Survey (GHS) or the 4th National Survey of Ethnic Minorities (SEM), from which self-reported information on ethnicity, income and health, with utilisation of health care can be linked. Despite the fact that acute hospitals have been required by the Department of Health to record ethnic group routinely since 1995, data on ethnicity on all types of routine NHS data are too poor to use in small area analyses.

Concerning *inpatient care*, using the GHS or SEM, several researchers have found no consistent difference in the rates of inpatient hospital utilisation between ethnic groups after adjusting for self-reported health status (76)(163)(164). The main exception was the Chinese population, in whom lower rates of utilisation of all health services have been consistently found.

Small area analysis studies have largely had to rely on area-aggregated data from the census. In the extensive analysis by the University of York, referred to earlier (99), researchers analysed the effect on acute hospital admissions (medical and surgical) of a variable measuring the proportion of the population not in black ethnic groups. In a model which included a range of 'individual', 'community' and 'health system' factors (including 'need factors relating to socioeconomic deprivation and SMR), the results suggested that areas with higher proportions of black residents had *lower* use of inpatient care than expected. The study team interpreted this finding as reflecting supply not need, suggesting that electoral wards with large ethnic minority populations tend to be located close to acute hospitals. A more likely explanation may be that black residents may be under-using inpatient care relative to their needs. There have been no small area studies of ACS admissions in the UK that have examined the influence of ethnicity.

Most smaller scale observational studies analysing use rates between different ethnic groups have not taken into account important confounding factors other than age and sex, for example socioeconomic deprivation or underlying prevalence of disease. It is therefore extremely difficult to assess the impact of 'ethnicity' *per se* on variations in hospitalisation rates. A recent review of the literature on ethnicity and use of NHS care for patients with coronary heart disease concluded that the evidence was so weak that it was impossible to draw conclusions about the equity of use between ethnic groups (165). But the few studies of this type that have adjusted for 'need' factors in some way suggest that there is inequity in access to care. For example, Shaukat *et al* showed that the time between onset of symptoms and being seen in outpatients for patients with suspected coronary artery disease was at least twice as long for Indian patients, having adjusted for the severity of disease subsequently found (166). Lear *et al* showed that following myocardial infarction, fewer Asians than Europeans were referred for diagnostic tests(167).

Concerning *outpatient care*, Smaje & Le Grand found that people in minority ethnic groups in the age group 0-44 years were *less* likely to report an outpatient attendance (164), although the picture was reversed for older members of the Black-Caribbean and Black-African population, who reported higher rates.

Concerning *primary care*, in contrast consultation rates in general practice have been found to be higher among ethnic populations, after adjusting for self reported health status, especially amongst the Asian and Caribbean population (164). The exception was the Chinese, young Pakistani females, and Africans, in whom lower rates have been reported.

Analysis of the MSGP-4 dataset appears to confirm the findings from survey data, with GP consultation rates higher in Caribbeans and Asians, and lower in the Chinese and African population after socioeconomic factors have been taken into account (82). Other surveys, that have not taken health status into account, suggest significant barriers to care for people from different ethnic groups. For example, in the National Patients Survey of General Practice in 1998, non-white people were less likely to report that they understood their GP, that they were given enough information and that their opinions had not been taken seriously by the GP, and were more likely to wait longer before being seen in outpatients (155).

Studies examining uptake of preventive care in primary care, for example screening for breast and cervical cancer, suggest that lower uptake rates are associated more with socioeconomic deprivation than ethnicity (10). In a review of a small number of studies on childhood immunisation, Smaje suggested that uptake has generally been found to be *higher* among minority ethnic groups, especially South Asian people compared to the white population (168).

To conclude, it is unclear from studies using aggregated survey data, such as the GHS or SEM, whether there is systematic inequity in use of NHS hospital care for ethnic populations. However, smaller scale quantitative studies on utilisation for specific conditions (typically coronary heart disease) suggest otherwise. There has been no relevant work analysing the impact on ethnicity on variations in hospitalisation for ACS conditions.

(d) Patient behaviour and lifestyle

The influence of patient lifestyle on hospitalisation has been examined mostly in studies of individual admissions rather than studies using aggregate data, and has been found to be important. For example drug or alcohol misuse has been found to contribute to 17% of admissions which could have been avoided, and lack of patient compliance with treatment has been estimated to lead to between 4% and 20% of admissions (169)(65)(170) and 11% of readmissions (171). Compliance has been shown to be influenced by a number of factors including, age, social class, the level of patient knowledge and beliefs about the illness and treatment, and the level of environmental support (172).

The influence of lifestyle-related factors on hospitalisation for ACS-type conditions has been estimated in ecological studies, by investigating the proportion of admissions in which substance misuse has been recorded on hospital discharge data. Billings showed that the proportion was almost 12% in New York City and there was a strong positive correlation between substance misuse and socioeconomic deprivation (1). The extent to which health care-seeking behaviour could be a factor explaining variations in hospitalisation rates for

ACS-type conditions has also been included in one multivariate analysis using data from a specially designed community survey, but was found to have no significant influence (22). No similar work has been conducted in the UK.

(e) Perceived access

Bindman *et al* in California sought to measure the *perceived* access to care of populations living in the geographical area under scrutiny (22). Residents of these areas were asked to rate, on a 5-point scale, their difficulty in receiving medical care when needed. Perceived access to ambulatory care was the single most important variable influencing variations in rates between zip code clusters - explaining over 50% of the variation. In a multivariate model, perceived access and prevalence were independently significant predictors of hospitalisation. The authors concluded that hospitalisation rates for ACS conditions were a suitable indicator of perceived access to ambulatory care; however this could be a circular argument.

In the UK, while ad hoc surveys show how various population groups perceive their access to care (155), few researchers, if any, have linked this information meaningfully with measurement of actual use of inpatient care in a way similar to the work in the US by Bindman *et al* described above.

(f) 'Health System' factors

The influence of four factors upon hospitalisation and ambulatory care is discussed briefly here: the hospital itself; supply of health services; organisation of care; and physician practice style.

(i) The hospital itself

Many studies have examined the impact of specific health system variables (discussed below) on variation in hospital utilisation rates across small areas. But few have examined the variation in small areas within and between hospital 'catchment' areas to identify the strength or otherwise of such a 'hospital effect'. Hospital catchment areas are sometimes referred to in the literature as 'hospital market areas' or 'hospital service areas', and have various definitions but generally mean areas in which the residents go mainly for their care to the particular provider in question. One important study, by Tedeschi and colleagues in the US, found that hospital utilisation rates in small areas (zip codes) *within* a hospital market area were more similar to each other than rates in small areas in other hospital market areas (173). After adjusting for income and age, the hospital market area explained 35% of the variance in surgical use rates and 39% in medical admission rates. The factors causing the apparently strong hospital effect were not discussed, although could clearly include a combination of those discussed below, as well as, for example, differences in the diagnostic coding of routine data between providers (see chapter 5). Tedeschi and colleagues concluded that the 'hospital effect' was important to take into account in further small area studies. How researchers have defined and identified 'hospital service areas' is discussed below.

(ii) Levels of supply and access to supply

Many cross-sectional ecological studies in US and UK have compared hospitalisation rates between hospital catchment areas because the supply of health system facilities can more easily be calculated than in geographical areas defined for other reasons (123)(174). Supply has usually been measured in terms of facilities per capita in an catchment area, such as the number of hospital beds or number of physicians. More sophisticated work has taken into account not only 'supply' but also distance from a facility (and neighbouring facilities) and the size of the population 'competing' for access to those facilities; in the UK these factors have been constructed as one variable which has been termed 'GP access' factor or 'hospital access factor' (99)(175), discussed below.

Hospital care

The supply of hospital facilities (such as beds, or doctors) in an area has consistently been found to have had an important positive influence on hospitalisation, and the association has been found more consistently for surgical procedures than medical admissions (72)(73)(99)(176)(177)(178)(179)(180)(181). For example, in a large cross sectional ecological study across 3 selected NHS regions in England and 4 NHS Health Boards in Scotland, the reasons for variation in rates between these areas (consisting of populations of approximately 250,000) for coronary revascularisation procedures in NHS and private providers were investigated(177). The researchers concluded that the variations were unrelated to need (measured as SMR per district for coronary heart disease) but were mostly due to the supply of hospital facilities available to carry out the procedures: the higher use rates observed for deprived communities were related to the proximity of residence to the provider carrying out the procedures.

There is a well documented inverse relationship between utilisation and distance to hospital facilities (99)(182), and with the size of the population 'competing' for the hospital resources. Researchers at the University of York have calculated a 'hospital access factor' for each small area in England, based on a formula that combined supply (the number of hospital beds in 5 specialties), distance to facilities from each small area, and the size of the populations competing for that supply in neighbouring small areas (99). In the multivariate analysis, the 'hospital access factor' was positively associated with hospitalisation rates, although the effect was weaker than for most of the 'needs' variables investigated.

Ambulatory care

The supply of ambulatory care facilities has received much less investigation, and most of the research has focused on primary care. In the US a number of studies have shown that the supply of primary care physicians or facilities, or outpatient facilities had a negative effect on overall hospitalisation rates (183)(184). Similarly in Canada , an overall negative association between the supply and access to primary care (general practice) facilities and hospitalisation has been found (185).

In three studies of ACS-type conditions, two also found a negative relationship between the supply of primary care physicians and admission rates (66)(123). However one of these found that, in a multivariate analysis, the negative association became weak and the positive association of supply of hospital beds did not reach statistical significance (123). The third study found a negligible effect between ACS admission rates and either the overall supply of physicians, or the proportions of specialists available (186). However this study was conducted in the Medicare population who, as a whole, enjoy significantly better access to health benefits than the rest of the US population.

In the UK, a recent large study by Jarman and colleagues, using data on 8 million discharges in England from 1991/2 to 1994/5, found a negative correlation between emergency admissions and the supply of general practitioners ($r=-0.35$, $p<0.001$)(187). But while very few large ecological analyses have examined the effect of supply of ambulatory care on hospital utilisation, observational studies have shown that inappropriate admissions can result from a lack of supply of ambulatory care facilities (188)(189).

In the study referred to earlier, researchers at the University of York investigated the association between hospitalisation rates and the supply of, and distance from, general practitioners and the size of the population competing for those facilities (99). This way the researchers attempted to measure access to general practitioner care, not just supply. The construction of the variable was similar to that used to construct the 'hospital access factor', discussed further in chapter 6. The York team put forward two alternative hypotheses as to the effect of the 'GP access factor':

- that there would be a *positive* relation between access to general practitioners and hospitalisation rates because, for example, GPs may be more likely to refer patients to hospital; or
- that there would be a *negative* relation since GP or other primary care may substitute for hospital care.

The team found an overall *positive* relationship after adjusting for need using standardised mortality ratios, standardised illness ratio and measures of socioeconomic deprivation.

However, they did not distinguish in their analysis between admission rates for surgical and medical conditions.

Other small area studies have demonstrated the effect of 'health system' factors on admission rates for ACS-type conditions. For example a study of admission rates for asthma (an ambulatory care sensitive condition) by general practice in a deprived part of East London found that a 'health system' factor (whether a practice had one or more GPs) was the strongest factor influencing admission rates (190): rates in practices with one GP were 1.7 times higher than those in practices with 3 GPs or more, and those in practices with two GPs were 1.3 times more. However this, like other studies, made no attempt to adjust adequately for need, making conclusions difficult to draw.

Not surprisingly the *supply* of ambulatory care has been found to be positively associated with *use* of ambulatory care (66) (91) and longer distance to ambulatory care facilities and longer waiting times have been found to deter use (110)(141)(191)(192)(193)(194)(195). Distance has been shown to have a greater deterrent effect on use of general practice care by women (192), the elderly and those in lower social classes even within same health status groups, although equal rates of referral and hospitalisation have been found after initial GP consultation (193).

Other work in the UK has investigated the relation between supply of primary care and need - that is, the relationship between variables within column (a) in figure 2. Since 1948 there have been strict controls over where general practices (the focus of much primary care activity) can be located, and the number of patients who can be registered with each practice. Despite efforts over the last 30 years, the so-called 'inverse care law' persists, that is to say that there are fewer GPs and attached practice staff and worse primary care facilities in socially deprived areas, in particular inner cities and in particular in London (107)(196)(197)(198). A recent national survey showed that the population in London, in particular people from black and ethnic minority groups, felt that they had greater difficulty accessing care from their GP than residents from other parts of England (155). The direct relation between lack of supply of primary care and use of ambulatory or hospitalisation rates in these areas has yet to be demonstrated.

(iii) Financing and organisation of care

Direct financial incentives

In the US, different arrangements and incentives for payment and organisation of care have been shown to have important effects on rates of health care utilisation.

Concerning inpatient care, significantly lower rates of hospitalisation have been observed among patients enrolled in managed care organisations, compared to those with similar risks in traditional fee-for-service insurance plans (199). 'In-system' access to discretionary procedures by hospitalised patients has been shown to vary considerably by insurance status, after adjusting for need (200). Other 'system' factors influencing hospitalisation rates include the introduction of new technologies (201), audit or surveillance of clinical practice (202), and the introduction of financial incentives for providers such as prospective payment (199)(203)(204) or disincentives to patients such as co-payments (205)(206)(207). Fewer studies have analysed the outcomes of care as a result of different methods of financing and organisation of care, although one large study (the Medical Outcomes Study) indicated that elderly and poor chronically ill patients had worse physical health outcomes in health maintenance organisations than in fee-for-service systems of care (208).

In the UK there have been fewer ecological studies of the effects of altering financial incentives to providers or users upon hospitalisation rates, because until the 1991 NHS reforms there were few direct financial incentives operating on patients or providers which might influence the utilisation of inpatient care. For acute hospitals after 1991, which were paid on a block contract basis (or cost and volume), the incentives to increase or reduce the level of hospitalisations were weak compared to the US (209).

For general practitioners, in 1991 the GP fundholding scheme was introduced whereby GP practices could be given a budget with which to buy prescription drugs and a limited range of hospital care (outpatient care and mainly elective surgery). The incentives for reducing expenditure on levels of hospital and outpatient care were weak, as was the impact of such incentives (210). In 1996 fundholding practices were given responsibility for purchasing medical admissions as well, although again the effect on admission rates was modest (209). Between 1991 and 1994 (the period covered by the analysis in this thesis) four main financial incentives operated for general practitioners relating to the way they were paid: *capitation payments* (which may have encouraged GPs to take on more patients up to a limit); *per-item fees* (for example for giving certain vaccinations); *target payments* (flat rate fees paid after a predetermined level of service has been reached) and *sessional fees* (for providing certain clinics eg promoting 'wellness' or managing chronic diseases such as asthma and diabetes). Of these, the incentives of the capitation payment (more payment for more patients) and sessional fees are likely to have most bearing on the care of patients with ACS conditions. On capitation payments, there is no strong evidence to suggest that GPs systematically increased their registered list of patients to attract higher income. Sessional fees have been shown to stimulate the provision of specific clinics (eg health promotion) in inverse proportion to the need of the local population (211), particularly in London (107).

Organisation of care

There has been increasing recognition that the way that *ambulatory* care is organised (affecting access and the quality of care provided) can have an important influence on the risk of subsequent admission to hospital. For example, in the US, case studies that have investigated factors in ambulatory care which may have led to admission in an individual patient have identified: sub-optimal clinical management (including inadequate follow up in ambulatory care, delayed diagnosis, failures of communication of results and poor planning); adverse drug reactions (65)(169)(170)(212); and a lack of health care facilities available in the community (189) (171)(213)(214)(215).

Despite efforts on both sides of the Atlantic, there is still no agreement as to which indicators might best measure the quality of primary care (69)(216)(217), and a comprehensive set is not yet available in the UK at least. Instead researchers have examined specific ad hoc features relating to various aspects of the organisation of primary care.

For example, whether populations have a regular source of care has been investigated as a factor. It is known from observational studies that barriers to primary care (real or perceived) result in greater use of a hospital emergency department, and therefore an increased risk of admission in the US (145)(146)(218)(219)(220) and UK (221)(222)(223)(224)(225) (226)(227). In the US, as noted above, people without a regular source of care tend to receive less ambulatory care (228), or preventive care (148); and lack of a regular source of care is associated with poverty, ethnic minority status, and greater use of A&E (and thus possibly greater likelihood of admission).

It is not clear how far having a regular 'facility' to go to, or a regular physician, affects the direct risk of subsequent hospitalisation. In the UK, almost all the population is registered with a general practitioner, but while patients may go to one practice for primary care, they may not receive care from the same clinician. The reasons for this partly relate to 'health system' factors (for example GPs in group practice may decide not to work with a personal list of patients (229)), and partly due to preferences of patients (158). However the link between the provision of continuity of care with a particular clinician, quality of care, access to and the use of ambulatory or inpatient hospital care remains unclear, despite the arguments for the beneficial effect on patient care (230)(231)(232).

More often observational or cohort studies have been used to investigate the effects of different forms of treatment provided in, or the organisation of, ambulatory care for specific conditions (labelled by others as ACS) using hospitalisation as an outcome measure. The aspects of quality of care that have been investigated include: levels of appropriate prescribing, organisation of care (for example sharing care with specialists, availability of a dietition for diabetic patients, having a practice-based protocol for care); and whether there has been clinical audit of care. Different forms of treatment or organisation of ambulatory care have been shown to reduce the need for admission in patients with asthma and diabetes (45)(233)(234)(235)(236)(237)(238)(239)(240)(241)(242)(243)(244)(245). For example Griffiths and colleagues in east London (239) found that higher admission rates for asthma by practice were associated most strongly with small size of practice and a high rates of night visiting, over and above differences in prescribing practice. However the prevalence of asthma (a measure of need) across practices was not taken into account in the analysis. Similarly a study of 318 patients with diabetes (another ACS condition) across 12 practices in Nottinghamshire found that more effective control of the disease was observed in practices holding special clinics, with GPs having a special interest in diabetes, and access to dietetic support and better equipment (246). A recent systematic review of the international literature on the effect of organisation on asthma care, found a lack of good quality research in the area. However studies that used the following outcome measures - attendances at accident and emergency departments, admissions to hospital, and readmissions – were found to result in a lower level of activity in these areas after a range of interventions in ambulatory care, for example using nurses to educate patients about asthma and to train patients more in the management of their disease and closer monitoring in primary care (247).

(iv) Physician practice-style

The large amount of variation in hospitalisation rates found in small area studies which remained unexplained after taking account of many of the factors discussed above led to the hypothesis that this may be due to differences in physician practice-style affecting the threshold of admission, particularly for treatments over which physicians have more scope for discretion in their decision-making (90)(112)(248)(249). The influence of physician practice-style was also suggested by Wennberg's observation that variations in surgical admission rates across locations appeared to be stable over time, leading some to suggest that surgeons working in those locations left a 'surgical signature' because of their particular practice-style. Attention then focused on measuring variations in use of care between physicians, rather than between geographical areas or population groups as discussed above. Initially few of these studies took casemix into account (250), but those that did showed that a large amount of variation between physicians remained unexplained by health or sociodemographic characteristics of patients or supply of local health care facilities. This has been particularly well illustrated in Canada (251)(252).

The majority of studies in this area have focused on analysing reasons for differences in rates of surgical procedures. Regarding medical admissions - which are more likely to be for ACS conditions - Connell *et al* examined patterns of hospitalisation for patients with one ACS-type condition (diabetes) and found that in higher rate areas, patients were admitted with less severe disease (253). This finding suggested that higher rate areas may be served by hospitals where physicians (referring or admitting) have a lower threshold for admission, rather than where patients necessarily have poor access to primary care.

But this finding has been contradicted in a few of the studies analysing hospitalisation for specifically ACS conditions. Two studies of avoidable hospitalisation across small areas in California surveyed physicians to ascertain their *propensity to admit* patients (22)(123). The physicians were asked to comment on hypothetical clinical vignettes to investigate how far clinical criteria (such as severity of disease) and also social criteria (such as being homeless, known to be non-compliant with treatment, being uninsured, and having no regular doctor) would influence their decision to admit a patient. No association was found between hospitalisation rates for ACS conditions and the propensity of physicians to admit. The team concluded that attempts to reduce hospitalisation may be better focused on improving access to care and reducing social inequalities rather than attempts to change physician practice-style. Two other studies of ACS admissions assessed the clinical severity of patients on admission (measured using clinical codes recorded on routinely collected discharge data) to assess the 'clinical threshold' of admission of the admitting physicians. But using this necessarily crude method, severity of disease or physician practice-style were not found to have a significant effect (1)(22).

The *gender* of the doctor may have important influence on practice style and subsequent hospitalisation although the evidence is mixed. For example although Coulter showed no evidence of an effect on the treatment of menorrhagia by GPs (254), others have shown that female GPs tended to refer women less often to hospital with gynaecological complaints and had higher uptake rates of cervical cancer screening among their patients (255).

The *age and experience* of physicians (referring or admitting) may also be important. For example, in Australia higher hospitalisation rates for diabetes were associated with patients from general practitioners of younger age with smaller caseloads of diabetic patients (181), suggesting that the level of clinical experience, or toleration of risk, of the referring doctor may be a significant factor.

How the referring or admitting physician reacts to predisposing or enabling factors (referred to earlier) in patients is also likely to be relevant. For example in the US, insurance status of the patient has been shown to influence clinical decision-making by ambulatory care physicians; fewer services are selected for uninsured patients than insured (256). In the UK, children from socially deprived backgrounds were more likely to be admitted from accident and emergency departments than those with similar illnesses from non-deprived families (161).

In general the *referral behaviour of general practitioners* in the UK and its impact on subsequent hospitalisation has not been well researched. One study found that while there was a positive relationship between the level of GP referral rates to hospital and surgical admissions, the relationship between referrals and medical admissions (which are more likely to include ACS conditions) was not significant (257).

2.5.5 Summary

Large scale population surveys, and ecological studies using routine hospital data, have both demonstrated the significant influence on hospitalisation rates of 'individual' 'community' and 'health system' factors.

Many small area studies have been unable to take account of need adequately in the analyses owing to the paucity of data on the levels of ill health, particularly for specific diseases, and are subject to problems of ecologic fallacy. However, 'need' factors (such as socioeconomic deprivation, limiting long term illness, and mortality and in the US income and race) have been shown to exert powerful effects on hospitalisation. Of particular note is that socioeconomic deprivation appears to have different effects according to the conditions for which individuals are hospitalised – for example deprived populations tend to experience more hospitalisation for ACS conditions, and less for discretionary procedures, such as for coronary heart disease.

'Health system' factors (especially the supply of hospital facilities) have been shown to be related to hospitalisation rates most consistently, particularly for surgical admissions. In the US, the payer of health care has also significant influence. However, since most studies investigating the effect of 'health system' factors have not made an adjustment for need in the analysis, the effect of supply variables is likely to be over-estimated. This may be so even if there is an adjustment for need, as need and supply are commonly counfounded. For example, more socioeconomically deprived, ethnic and older, populations tend to live in inner cities in areas where the supply of inpatient facilities is likely to be higher.

The influence of supply of, or access to, ambulatory care on the subsequent use of hospital care has been investigated much less - most studies have been carried out in the US. There, several studies have found a negative association between supply of primary care physicians and hospitalisation rates, especially for ACS conditions. In the UK, a positive relation has been found for all admissions (not distinguishing between medical and surgical) (99).

There have been fewer ecological studies analysing the impact of varying factors upon use of ambulatory care because fewer data are available for analysis. Primary care has been investigated more than other forms of ambulatory care. Multivariate analyses of variations in use of primary care suggest that 'individual' factors have more explanatory power than 'community' or 'system' factors.

More qualitative studies have demonstrated the complex array of factors that may influence both whether an individual seeks care, and how the individual is treated within the health care system including access to further health care. These factors relate to structural aspects of the health care system (such as physical location of facilities, and the requirement of co-payments), and characteristics of physicians, patients as well as the condition treated. This complexity is likely to mean that what can be gained from the results of ecological studies is limited, although the results of these studies may raise useful questions for further in-depth analyses.

2.6 Implications of literature for the design of this study

<u>**Section outline**</u>

2.6.1 General comments

2.6.2 Specific methodological issues

- **(a) Why a small area analysis?**
- **(b) Size of small area**
- **(c) Identifying random variation**
- **(d) Type of analysis**
- **(e) Selection of variables**
  - **(i) Dependent variable**
    - ***Identifying ACS and marker conditions***
    - ***Accuracy of coding***
  - **(ii) Independent variables**
    - ***Need***
    - ***Age and sex***
    - ***Health system factors***
    - ***Ethnicity***
    - ***Other factors***

2.6.1 General comments

One important message from this review is that access to and use of health care is influenced by a range of factors, many of which are interrelated in a complex way. In particular, access and use are influenced by the 'need' for care, and it is important to take account of 'need' in any investigation of the equity of access to ambulatory care.

The literature also shows that, while a great deal of research has been conducted, there are significant gaps. In particular there has been no published study in the UK in which variations in admission rates for a range of ACS conditions have been analysed.

In the proposed investigation, equity of access to ambulatory care will be investigated. The definition of equity to be used will be equity of access for equal need, and hospitalisation rates for ACS conditions will be used as a negative indicator of access to timely and effective ambulatory care. The form of ambulatory care focused on in this study will be that provided in primary care rather than in other settings (for example hospital outpatient or accident and emergency departments, or minor injuries clinics). The reason for this decision was partly to keep the investigation relatively simple in the first instance, and partly because for the large majority of people in the UK the first point of contact for health care is their general practice, probably with a GP. Variations in hospitalisation rates for ACS conditions will be compared to variations observed for 'marker' (non-discretionary) conditions - as examined in the US by Billings.

Of all the possible factors which might influence variations in hospitalisation rates, it was thought important to analyse the impact of eight of those discussed above: standardised illness ratio; standardised mortality ratio; socioeconomic deprivation; age; sex; access/supply of hospital facilities; access/supply of primary care facilities; and 'hospital effect'. It was thought that this would be a useful start, and more than enough work for one thesis. Chapter 6 describes the investigation.

To gain further understanding of why admission rates for ACS conditions were high in particular locations, qualitative studies, rather than large scale multivariate analyses using routine data, would also be required but were beyond the scope of this thesis.

2.6.2 Specific methodological issues

(a) Why a small area analysis?

A small area analysis approach has been favoured by researchers investigating variations in admission rates for ACS and marker conditions. The term 'small area analysis' essentially indicates that the factor of interest (admissions) has been calculated and compared across small geographical areas, and reasons for variation between small areas investigated. In most studies of this kind, there have been particular reasons for choosing an analysis by area, rather than, for example, by population group. These include the following:

- spatial distance from a person's home to health care facilities may be an important factor to take into consideration in the analysis. These data are not available for individuals, but are available aggregated by small area;

- routine data are available to document the characteristics of the area (eg from the census) and include in a multivariate analysis;

- identifying high or low admission rates by area on a map may be a useful way to interest policy-makers in further investigation, or in the design of interventions, focused on areas of interest; and

- information on 'health system' characteristics (eg numbers of hospital beds) and 'need' (such as mortality rates) are available by area, and not specific to individuals.

All of these were relevant to the investigation in this thesis, so a small area approach will be used.

The main disadvantages of small area analyses are that:

- attribution of the characteristics of an area to an individual (in this case one who is admitted), which may not be appropriate (the problem of 'ecologic fallacy');

- there is little information on health status available at small –area level, making it difficult to make an adequate adjustment for need in the analysis;

- the use of aggregated datasets necessarily means a broad-brush enquiry. More focussed and detailed studies will be needed to understand a fuller picture of, for example, the relationship between admission for an ambulatory care sensitive condition, socioeconomic deprivation and access to ambulatory care.

(b) Size of small area

In the UK and US, routine hospital admissions data are 'geo-coded' - in the UK a patient's postcode in recorded, in the US a zip code - allowing admission rates by small area to be calculated. In the US 'small areas' have included individual zip codes (roughly 30, 000 population) (1), zip code clusters (22), cities (176) or States (72). In the UK they have generally included enumeration districts (pop size approximately 500), electoral wards (pop size approximately 10,000), health authorities (size from 500,000) and regions (approximately 3-5 million).

There appears to be no optimim size of small area for analyses: choice of size depends upon the aims and objectives of the study, and the number of events of interest per area. In the case of hospital admissions, choosing small areas with a *large* population size may be advantageous because more admissions are captured and less of the variation between area will be due to chance. But if area-based information is used to document the characteristics of the area, then small areas covering *small* populations may be better because the likelihood of ecologic fallacy is reduced (12). Some researchers have suggested that whatever the size of population covered by a small area, a more important factor to consider for the analysis is the *variation* in population size between small areas, because a larger variation can make it more difficult to detect the extent of random versus non-random variation in events between these areas (258). Others have suggested that, at the very least, researchers should document the variation in population size between areas (72).

In this study census enumeration districts (EDs) (rather than the larger electoral wards) were chosen as small areas partly to reduce the risk of ecologic fallacy, and partly to identify hospital service areas (see below and chapter 6) with more refinement. The disadvantage of choosing EDs rather than larger areas was that there would be more random variation in hospitalisation rates between them.

(c) Identifying random variation

A number of papers investigating the best statistical test for random variation among small areas have been published. Paula Diehr and colleagues (259) used simulation models to test the robustness of a variety of statistical tests. They favoured the chi-squared model over others such as the extremal quotient and the systematic component of variation used by other researchers. Others have noted the importance of testing for spatial autocorrelation – which tests for the possibility that scores between neighbouring small areas may not be independent of spatial location (260).

(d) Type of analysis

In most small area analyses, researchers have gone further than simply documenting variations between small areas. Usually some type of multivariate regression analysis is performed (72) (73), in which the correlation of a number of independent variables with the dependent variable (hospitalisations) is investigated to identify which independent variables have most influence.

There are various types of regression analyses, used under different conditions. If the number of events per small area is small and they are random in nature, as is the case with hospitalisations, then a Poisson regression is normally used (261). This type of regression will be used in this thesis.

(e) Selection of variables

(i) Dependent variable – hospital admissions for specific groups of conditions by small area

Identifying ACS and marker conditions

The dependent variables to be used will be admissions for ACS and marker conditions. A crucial first step in the study will be to identify such conditions in a way that has face validity in the UK. The literature suggests that consensus development may be a suitable method for this. The US studies discussed above did not appear to consider the *degree* of likely avoidability of admissions for certain conditions, or the extent to which ambulatory care might have an effect on either *preventing the onset of the condition*, or *preventing admission for an existing condition*. Furthermore most of the US studies discussed were not specific about the type of ambulatory care which could have most effect in reducing the need for hospitalisation. It might be important to fill these gaps; chapter 3 gives more details.

Accuracy of coding

Clearly any small area analysis is vulnerable to the quality of the data used. It is striking that this fact is largely ignored in the literature. It was thought important in this thesis to analyse the quality of routine data on hospitalisation in the HES dataset, and in particular the diagnostic coding. Chapters 4 and 5 describe this analysis.

(ii) Independent variables

Need

A crucial step in the analysis will be to take some account of 'need' - in particular the prevalence of the specific ACS and 'marker' conditions under study. As noted above, researchers have had great difficulty in allowing for this owing to the lack of geographically based information on prevalence of disease or health status. However reference has been made to the small area variations work at the University of York, in which a combination of area-based standardised mortality ratio (SMR), and standardised illness ratio (SIR) were calculated for small areas (electoral wards), using data from the 1991 census. This offers a promising way to account for ill health, however non-specific, since other data on health status are not available by small area. Of course this does not take into account the potential to benefit from health care.

Another 'need' variable to take account of in the analysis is socioeconomic deprivation. As shown above, research suggests that the relationship between deprivation and hospitalisation rates is different for different types of conditions: medical (and in the US, ACS) conditions; 'discretionary' (elective) surgeries; and 'marker' conditions such as fractured neck of femur. As indicated in the introduction, one of the questions to be addressed in this thesis is whether there is such a strong association between socioeconomic deprivation and hospitalisation rates for ACS and marker conditions in the UK NHS. If so, this may indicate that access to ambulatory care (in particular primary care) is a problem in the NHS (as suggested in the US), or not (as suggested in Canada). From the literature discussed above, it was decided to use the Carstairs index in the analysis.

Age and sex

Clearly it is important, for the reasons outlined earlier, to take into account the effects of age and sex in analyses of hospitalisations.

'Health system' factors

From the literature, of all the potential 'health system' factors it seems most important to take account of access to primary care facilities (in particular access to care by general practitioners), and access to inpatient facilities. As discussed, the main literature on constructing such variables is that produced by researchers at the University of York; it was decided to construct the variables in a similar way.

After Tedeschi's work (173), the other 'health system' variable it might be important to take account of is the 'hospital effect'. This involves identifying hospital 'catchment', 'market' or 'service' areas. The term 'hospital service area' (HSA) will be used in this thesis. Two main methods have been to define a HSA. In the first, the small area is 'assigned' to a hospital's HSA if there are more admissions from the area to that hospital than to any other. This is termed in the literature the 'plurality rule' (262). *All* admissions occurring in residents of that small area are then assumed to be subject to the same hospital effect as for Hospital A, even though in fact a proportion of admissions may have occurred in other hospitals.

In the second, a small area is assigned to a hospital's service area if *more than a specified* *proportion* of all admissions in residents occur at that hospital - say 50%. Again, all admissions occurring in residents of that small area are then assumed to be subject to the same hospital effect as for Hospital A.

In this analysis, both approaches were used. At first EDs were assigned to a hospital service area according to the plurality rule, then EDs were only included in the hospital service area if a specified proportion of admissions has occurred in the hospital. A provisional cut-off proportion was defined that was low enough not to exclude too many EDs from the analysis and yet high enough to avoid blurring any individual 'hospital effect' (see chapter 6).

A further decision was taken at this stage to limit the small area analysis to census enumeration districts only in HSAs serving the largest acute hospitals within the North West Thames region. Larger hospitals would be more likely to, it was assumed, a) admit patients with a full range of ACS and marker conditions (because the hospitals would have the required full range of specialities), b) have staff with greater expertise in diagnostic coding of routine activity data, and c) have a larger number of EDs contained within their HSA.

Finally, because patterns of admissions change over time, HSAs were to be calculated for each year for which admissions data were available at the beginning of the study – 1991/92, 1992/93, 1993/94.

Ethnicity

The UK literature contained mixed messages on the impact of ethnicity on variations in hospital admission rates. Because of this, and the inadequacy of coding of ethnicity on routine NHS admissions data, it was decided to exclude this variable from the analysis.

Other factors

Finally, other factors shown in the discussion above to have impact on hospitalisation rates included perceived access, and clinician practice style. These, and other factors not generally investigated, such as utilisation of ambulatory care, were thought to be of secondary importance in this thesis, to be investigated using multivariate analyses if the variations between small areas in the UK were shown to be large, and if a significant amount of variation remained after multivariate analysis using the eight main factors above.

Chapter 3 Identifying admissions for further study

3.1 Introduction

The next step in the project was to identify and select the admissions that would be studied further in the small area analysis described in chapter 6. This chapter is divided into three sections. First there is a brief discussion about several broad categories of admissions that were excluded at the start from further analysis. This is followed by a description of how ACS and marker conditions were identified. The third section shows how and why other groups of admissions were identified to be included in the small area analysis.

3.2 Excluding broad categories of admissions

From the outset it was decided to exclude from further analysis three broad categories of admissions. The first was admissions in persons aged 75 years or older. One reason was because an aim of the study was to be able to compare findings with those of Billings' *et al* (1), as noted in the introduction, whose study examined admission rates in persons aged under 65 years. 75 years rather than 65 years was chosen in order to ensure that there were a reasonable number of events (admissions) per small area for the analysis. Another reason for excluding these older patients was because identifying the diagnosis that caused the admission (recorded on routine hospital activity data) was likely to more difficult in an age group with a greater prevalence of multiple morbidities.

The second group excluded were admissions in well babies born in hospital since these admissions were unlikely to be influenced by access to, or quality of, primary care. The third group were admissions in certain specialties (see below) - obstetrics, psychiatry, mental handicap, dental medicine - because these had also been excluded in the Billings' study. Admissions for neoplasms were also excluded for the same reason.

3.3 Identifying ACS and marker conditions

As noted in chapter 2, the US literature shows that lists of conditions for which ambulatory care could prevent a hospital admission have typically been drawn up using a literature review and the considered judgement of a few experts. The methods by which the judgement was arrived at have not been fully described, although it is clear that in at least one case a method to develop a consensus was used (1). It was thought that a systematic method of arriving at a consensus should be used in this study.

The US studies discussed above did not appear to attempt to gain consensus on the *degree* of likely avoidability of admissions for certain conditions, or the extent to which ambulatory care might have an effect on either ***preventing the onset of the condition***, or ***preventing admission for an existing condition***. This thesis aimed to fill these gaps.

3.3.1 Methods

(a) The approach to consensus development

There are three generally accepted formal methods to develop a consensus opinion:

- a *consensus development conference* (263)(264), in which a 'jury' hears and considers expert evidence before establishing a consensus view. This was rejected as too costly for our purpose and inappropriate because of the numbers of clinical conditions to be considered;

- a *Delphi exercise* (265), in which a panel of around 10 experts complete a series of postal questionnaires, interspersed by anonymised postal feedback on the results of each successive round. This was also ruled out on the grounds that the advantages of meetings for explanation and clarification of the task and 'live' debate between panellists would outweigh the disadvantages of cost and loss of anonymity;

- the *nominal group technique (NGT)* (266)(267), like Delphi, involves several rounds, but experts meet at least once to discuss their differences and usually complete questionnaires at their meetings.

The nominal group technique (NGT) was accepted as the most appropriate method for this study. However because it was anticipated that the number of conditions for 'experts' to review would be too large to be completed in a meeting, it was decided to allow experts to complete the questionnaire outside of the meeting and post back the results. This combination of meetings and questionnaire rounds is closest to what has been described as a modified NGT (267).

(b) Developing consensus

Three panels of participants were convened. Each panel was provided with a different list of clinical conditions, and for each condition members were asked to consider three questions:

Q1 Can *onset* of the condition be prevented by timely and effective ambulatory care (eg by appropriate screening or risk factor management)?

Q2 (Given onset) can *admission* be averted by timely and effective ambulatory care (eg by remedy, stabilisation or preventing complications)?

Q3 Once admission is indicated, should it take place *within 48 hours*?

'Ambulatory care' was defined as care of an acute, episodic or chronic illness or condition in any setting other than in a hospital inpatient setting. Care included screening and risk factor management as well as treatment. Care was 'timely and effective' if it stopped the condition deteriorating to the point at which admission was needed, and was 'practical and reasonable' in the current NHS. Panellists were asked to respond on the basis of their own experience of patients admitted to hospital for the condition.

The first two questions were designed to help identify ambulatory care sensitive (ACS) conditions and ambulatory care insensitive (ACI) conditions, the third to identify 'marker' conditions. For each question, each panellist assigned each condition to one of the following six categories: 1 (0-4% of the time); 2 (5-29%); 3 (30-49%); 4 (50-69%); 5 (70-94%) and 6 (95-100%). There was space on the questionnaires for comments, and participants were asked not to respond for conditions outside their normal area of expertise. No evidence from the literature was supplied.

For panel A in the first round, only questions 2 and 3 were posed. It was agreed at the first meeting that question 1 should be added to all subsequent questionnaires for all panels, to avoid confusion between effective primary prevention and effective care of existing disease.

Each panel met on two occasions and completed three rounds of the same questionnaire. The schedule is shown in table 7. The meetings were facilitated, ensuring that all had an opportunity to speak, all were drawn into the discussion, and all conditions were discussed. An observer recorded key points and decisions.

Table 7 The consensus development process

Schedule	Task		
week 1	**1st panel meeting**	-	introduce project
		-	distribute and discuss questionnaire
		-	discuss each condition on list
		-	panellists take questionnaire away with them
week 4	1st round questionnaire returned, completed		
week 8	2nd round questionnaire sent out: with group response (modes and ranges) and addressee's own response in round 1		
week 12	2nd round questionnaire returned completed		
week 16	3rd round questionnaire sent out: with group response (modes & ranges) and addressee's own response in round 2		
week 17	**2nd panel meeting**	-	discuss results
week 20	3rd round questionnaire returned		
week 22	Group responses (medians and interquartile ranges) analysed		

(c) Selecting conditions to be reviewed

The numbers of conditions reviewed had to be kept to manageable proportions. It was decided not to consider diagnoses likely to occur in admission categories already excluded (see above) - ICD-9 codes in several ICD-9 chapters:V (mental disorders); XI (complications of pregnancy, childbirth, and puerperium); XV (conditions arising in the perinatal period); and codes 520-525 (diseases and conditions of teeth). ICD-9 codes in Chapter II (neoplasms) were not expected to yield many ACS conditions, and so these were largely excluded. The remaining conditions were identified from a frequency distribution of all ICD-9 diagnosis codes (268) that appeared on hospital discharge data for the 3.5 million residents of North West Thames NHS Region during one year – 1990/91.

Conditions represented by ICD-9 codes were selected for review if they had appeared more than 400 times in discharge records, (not necessarily as the main diagnosis) during 1990/91. Some codes were grouped where this seemed appropriate (for example, cellulitis of the back or buttock formed one group; cellulitis at other sites formed another). Codes indicating evidently non-specific symptoms and signs were excluded (for example, 799.9: 'unknown cause of morbidity or mortality'). In a secondary list, codes were selected if they appeared between 100 and 400 times and it seemed likely that the onset or admission could be affected by ambulatory care. The choice of these was made by a public health physician (JD). In all, there were 166 conditions (45 with less than 400 discharges) in the initial list.

(d) Selection of panellists

Clinicians who were advisors in each clinical specialty to the then North West Thames Regional Health Authority were asked to suggest possible panel members. Of 27 general practitioners (GPs) contacted, 17 agreed to participate. Of the 31 consultants contacted, 17 agreed. The 34 participating clinicians were grouped into 3 panels. Panels A and B reviewed conditions normally treated by clinicians working in the specialties of general medicine, paediatrics or general surgery. Panel C reviewed conditions in other specialties such as gynaecology, orthopaedics and ear, nose and throat (ENT). Consultants were allocated to groups according to their specialty, and the GPs according to their own choice. The composition of each panel is shown in table 8.

Table 8 Composition of panels

Panel	No. of GPs	No. of Consultants	Specialties represented
A	5	5	General Surgery General Medicine Rheumatology Cardiology Renal medicine General practice
B	5	5	Gynaecology Orthopaedics Ophthalmology ENT General practice
C	7	7	General Medicine General Surgery Paediatrics Respiratory Medicine Cardiology General practice

(e) Data analysis

To each question, panellists indicated their response by marking one of the 6 categories noted above. Median percentages and interquartile ranges were calculated for the responses to each question and each condition, using an interpolation method for grouped data (269) which assumes that values are spread evenly across categories. Thus the minimum possible median score for each question was 2.5% and the maximum possible was 97.5%. Scores for panellists who only completed one round were excluded. For panellists who did not complete the final round, second round scores were taken as final. The extent to which scores for a condition converged between rounds 1 and 3 was examined using only results for participants who had completed scores in all three rounds. For each panel, the closeness of agreement was indicated by the median interquartile range over the conditions considered. Consensus was characterised as 'poor' if, after excluding at most one outlier panellist per condition, the remainder of the responses covered more than three adjacent categories.

Conditions were defined as ambulatory care sensitive (ACS) if 70% or more admissions were judged avoidable by better prevention or if 70% or more were judged avoidable by better management in ambulatory care. Conditions were defined as 'weakly ACS' if not ACS and either 50-69% of admissions were judged avoidable by better prevention or 50-69% were judged avoidable by better management in ambulatory care. The rest were defined as ACI (ambulatory care insensitive). Each of these three groups was subdivided into 'urgent' and 'others' according to whether 70% or more admissions were judged to be normally required within 48 hours or not (question 3).

'Potential markers' are the subset of ACI conditions for which less than 30% of admissions could be avoided by prevention of onset and less than 30% avoided by appropriate management. Actual 'marker conditions' are, in turn, a subset of these for which 95% or more admissions were judged necessary in less than 48 hours. The layout of table 10 helps to clarify these definitions.

3.3.2 Results

(a) Attendance

Data were discarded for one panellist who only completed one round of the questionnaire. Two members of panel C did not complete the first questionnaire and one from each panel did not complete the third questionnaire.

(b) Items excluded or modified during panel meetings

There were 12 conditions that the panels were unable to classify, either because they were too unspecific (eg 'other diseases of nasal cavity and sinuses' - code 478.1), or because they were considered unlikely ever to be the main cause of an admission and therefore difficult to classify (eg 'coronary atherosclerosis', 414.0). The four-digit ICD-9 codes for diabetes did not distinguish between insulin dependent and non-insulin dependent diabetes, and these were considered separately in the second and third rounds of the questionnaire. Thus the initial 166 conditions became 155. One condition, ophthalmic complications of diabetes (250.4), was inadvertently reviewed by two panels. The final scores were based on average response rates over all questions of 99% for GPs and 97%, 84% and 91% for consultants in panels A, B and C, respectively. Almost all of the non-responses by consultants arose because they felt that the question lay outside their area of expertise.

(c) 'Ambulatory care sensitive' and 'ambulatory care insensitive' conditions

Tables 9, 10 and 11 give the results for the individual conditions. As well as identifying conditions that are ACS (table 9), weakly ACS (table 10) and ACI (table 11), the table also separates those for which admission is 'usually urgent' and 'usually not urgent', and those for which prevention is more or less likely to play a role. 'Markers' are shown in bold. Results for conditions with fewer than 400 admissions in 1990/91 (labelled in the table as 'also') are indicated by listing their ICD-9 codes in the appropriate areas of the tables.

Table 9 Ambulatory care sensitive conditions (responses to Q1= or >70% or Q2 =or > 70%)

(a) avoidable primarily through effective management in ambulatory care (Q1<30%)

		ADMISSION USUALLY URGENT (Q3 = or >70%)								ADMISSION NOT USUALLY URGENT (Q3 = or <70%)					
		Q1		Q2		Q3				Q1		Q2		Q3	
ICD-9 Code	Condition	Median	IQR	Median	IQR	Median	IQR	ICD-9 Code	Condition	Median	IQR	Median	IQR	Median	IQR
345.9	Epilepsy unspec	3.0	3.0	78.3	25.8	97.0	3.0	78.1	Viral warts	4.2	15.4	97.2	2.8	2.5	2.5
493.0	Asthma extrinsic	3.3	3.3	76.3	20.6	96.7	3.3	706.2	Sebaceous cyst	2.8	2.8	97.2	2.8	2.8	2.8
493.9	Asthma unspec	3.3	3.3	74.2	24.7	96.7	3.3	727.4	Ganglion and cyst of	2.5	2.5	77.1	19.4	2.5	2.5
813.4	Fracture of radius & ulna	3.6	7.4	70.0	29.2	96.9	3.1		Synovium, tendon, bursa						
	(lower, closed)							622.0, 622.1,	Dysplasia cervix, mucous	5	15.0	72.5	22.5	2.5	2.5
79.9	Viral infection unspec	3.6	9.5	74.2	22.1	90.0	19.4	622.7	polyp, erosion of cervix						
250.0	Diabetes (insulin dependent)	3.0	3.0	73.6	24.3	70.0	25.0		Dyspepsia and other	25.0	27.5	76.3	29.4	13.3	19.6
								536.8	Stomach function disorders						
Agree?	463, 599.0							*also*	373.2, 374.0, 616.0						

Key: '*agree?*' indicates poor consensus (see text); '*also*' indicates fewer than 400 admissions in the North West Thames dataset; bold type indicates marker conditions; IQR, interquartile range; nec, not elsewhere classified; unspec. unspecified; w, with; w/o, without; ACS, ambulatory care sensitive.

Table 9 Ambulatory care sensitive conditions (Q1 = or >70% or Q2 > 70%) and (Q1>30%)
(b) Also with scope for prevention in ambulatory care (Q1 >30%)

		ADMISSION USUALLY URGENT (Q3 >70%)								ADMISSION NOT USUALLY URGENT (Q3 <70%)					
		Q1		Q2		Q3				Q1		Q2		Q3	
ICD-9 code	Condition	Median	IQR	Median	IQR	Median	IQR	ICD-9 code	Condition	Median	IQR	Median	IQR	Median	IQR
251.2	Hypoglycaemia unspec	76.3	22.3	79.4	18.8	97.3	2.7	703.0	Ingrowing toenail	60.0	18.6	96.4	9.4	3.0	3.0
682.0	Cellulitis of face, etc	50.0	26.7	74.2	22.1	79.4	15.6	564.0	Constipation	70.0	28.1	80.0	25.8	55.7	17.9
250.0	Diabetes (non-insulin dependent)	32.0	27.1	80.0	25.8	70.0	28.1	280	Iron deficiency anaemia	60.0	12.5	74.2	22.1	37.1	12.9
								707.1	Lower limb ulcer (except decubitus)	60.0	16.7	74.2	22.1	20.6	28.4
								531.9	Gastric ulcer unspec w/o Haemorrhage or perforation	46.0	21.5	70.0	25.0	30.0	22.5
								535.5	Gastritis and duodenitis unspec	46.0	24.0	70.0	22.5	30.0	25.0
agree?	435							*agree?*	401.9, 530.1, 532.9						
								also	532.7						

Key: '*agree?*' indicates poor consensus (see text); '*also*' indicates fewer than 400 admissions in the North West Thames dataset; bold type indicates marker conditions; IQR, interquartile range; nec, not elsewhere classified; unspec, unspecified; w, with; w/o, without; ACS, ambulatory care sensitive.

Table 10 Weakly ambulatory care sensitive conditions (not ACS and; Q1 >50% or < 70%, or Q2 >50% or < 70%)
(a) avoidable primarily through effective management in ambulatory care (Q1 <30%)

		ADMISSION USUALLY URGENT (Q3 = or >70%)					
		Q1		Q2		Q3	
ICD-9 code	Condition	Median	IQR	Median	IQR	Median	IQR
345.1	Generalised cunvulsive epilepsy	3.0	3.0	61.1	13.3	97.0	3.0
464.4	Croup	2.5	2.5	60.0	16.7	97.5	2.5
481	Pneumococcal pneumonia	9.2	18.7	58.6	17.1	96.7	3.3
485	Bronchopneumonia	16.3	16.3	56.3	19.4	95.4	19.9
465.9	Upper respiratory tract infection Unspec	17.5	18.8	60.0	15.0	96.7	3.3
agree?	428.9						

		ADMISSION NOT USUALLY URGENT (Q3 <70%)					
		Q1		Q2		Q3	
ICD-9 code	Condition	Median	IQR	Median	IQR	Median	IQR
626.2	Excessive or frequent menstruation	4.0	11.3	58.6	11.4	3.3	3.3
626.8	Dysfunctional or functional uterine Haemorrhage, NOS	4.0	11.3	60.0	10.0	3.3	3.3
715.9	Osteoarthritis (unspec if generalised or localised)	4.5	17.3	54.0	22.0	3.2	3.2
354.0	Carpal tunnel syndrome	17.5	22.5	60.0	12.9	2.5	2.5
332	Parkinson's disease	3.1	3.1	65.7	27.8	37.8	12.2
340	Multiple sclerosis	2.8	2.8	55.7	16.2	41.4	14.3
553.3	Diaphragmmatic hernia	15.4	18.8	62.9	12.9	11.3	32.2
556	Idiopathic proctocolitis	2.7	2.7	59.1	10.9	44.3	19.3
714.0	Rheumatoid arthritis	2.8	2.8	64.3	17.0	35.7	19.1
780.6	Pyrexia of unknown origin	2.5	2.5	57.1	21.4	51.4	21.7
574.2	Calculus of gall bladder without cholecystitis	4.1	11.7	57.8	14.4	58.8	16.3
558	Other non-infective gastroenteritis/colitis	23.8	29.4	62.5	12.5	56.7	20.0
562.1	Diverticular disease of colon	17.5	18.1	61.8	11.8	44.4	20.3
585	Chronic renal failure	27.5	25.4	58.3	15.0	58.8	11.3
agree?	569.3, 553.3, 722.1, 715.3						
also	365.9, 378.9, 603.9, 626.6, 714.3, 471.0, 625.0, 625.3						

Key: '*agree?*' indicates poor consensus (see text); '*also*' indicates fewer than 400 admissions in the North West Thames dataset; bold type indicates marker conditions; IQR, interquartile range; nec, not elsewhere classified; unspec, unspecified; w, with; w/o, without; ACS, ambulatory care sensitive.

Table 10 Weakly ambulatory care sensitive conditions (not ACS and; Q1 >50% or < 70%, or Q2 Q1 >50% or < 70%)
(b) also scope for prevention in ambulatory care (Q1 >30%)

ADMISSION USUALLY URGENT (Q3 =or>70%)

		Q1		Q2		Q3	
ICD-9 code	**Condition**	**Median**	**IQR**	**Median**	**IQR**	**Median**	**IQR**
9.1	Colitis, enteritis, etc. of infectious origin	50.0	22.5	61.1	11.1	77.5	23.8
250.1	Diabetes with ketoacidosis	60.8	10.8	58.2	11.8	97.0	3.0
428.1	Left heart failure	53.8	29.4	59.2	10.8	95.0	21.3
780.3	Convulsions	51.4	29.0	65.7	22.3	96.4	9.4
413	Angina pectoris	45.0	25.0	53.3	21.7	96.9	3.1
427.3	Atrial fibrillation and flutter	35.7	25.4	60.0	10.0	80.7	17.9
agree?	788.2, 959.4						
also	25.1						

ADMISSION NOT USUALLY URGENT (Q3 <70%)

		Q1		Q2		Q3	
ICD-9 code	**Condition**	**Median**	**IQR**	**Median**	**IQR**	**Median**	**IQR**
250.4	Diabetes with ophthalmic manifestations	55.7	16.2	60.0	10.0	57.5	12.5
496.0	Chronic airways obstruction nec	56.3	18.1	60.0	14.4	68.6	24.5
428.0	Congestive heart failure	33.8	22.8	59.0	13.0	64.4	19.0
285.9	Anaemia unspecified	55.0	25.0	61.1	11.1	43.3	20.0
535.6	Duodenitis	45.0	25.0	64.3	17.0	30.0	25.0
614.9	Pelvic inflammatory disease female, unspec	40.0	12.5	60.0	12.5	41.1	11.1
565.0	Anal fissure	57.5	12.5	58.9	11.1	25.8	24.6
454.9	Varicose veins of lower extremities w/o ulcer or inflammation	40.0	16.7	60.0	16.7	2.8	2.8
727.0	Synovitis and tenosynovitis	35.0	21.9	65.0	21.9	3.2	3.2
agree?	8.8, 443.9, 474.0, 618.0, 381.0, 466.0						
also	9.3, 625.6, 473.9, 455.0, 455.2, 455.6, 384.2, 530.2, 535.4, 682.5						

Key: '*agree?*' indicates poor consensus (see text); '*also*' indicates fewer than 400 admissions in the North West Thames dataset; bold type indicates marker conditions; IQR, interquartile range; nec, not elsewhere classified; unspec, unspecified; w, with; w/o, without; ACS, ambulatory care sensitive

Table 11 Ambulatory care insensitive conditions (Q1<50% and Q2 <50%)

(a) Some scope for prevention or management in ambulatory care (Q1>30% or Q2 >30%)

	ADMISSION USUALLY URGENT (Q3 = or>70%)	Q1		Q2		Q3	
ICD-9 Code	**Condition**	**Median**	**IQR**	**Median**	**IQR**	**Median**	**IQR**
451.1	Phlebitis and thrombophlebitis of deep vessels	40.0	12.5	41.4	14.3	95.8	32.9
578.9	Haemorrhage of gastrointestinal tract unspec	42.2	14.4	37.0	13.0	96.8	3.3
592.1	Calculus of ureter	10.4	18.7	38.8	16.3	96.4	12.6
410	Acute myocardial infarction	36.7	35.8	4.2	12.3	97.5	2.5
415.1	Pulmonary embolism	42.5	23.8	2.8	2.8	97.5	2.5
577.0	Acute pancreatitis	40.0	16.7	3.1	3.1	97.5	2.5
466.1	Acute bronchiolitis	3.0	3.0	45.0	28.0	96.7	3.3
574.0	Calculus of gall bladder with acure cholecystitis	3.6	9.4	36.3	20.6	97.0	3.0
566	Abcess of anal and rectal regions	3.3	3.3	35.6	22.2	81.3	16.3
850	Concussion	33.3	37.5	35.0	30.0	96.9	3.1
agree?	550.1, 436, 977.9, 574.1						
also	282.6, 532.4, 616.3						

	ADMISSION NOT USUALLY URGENT (Q3 70%)	Q1		Q2		Q3	
ICD-9 code	**Condition**	**Median**	**IQR**	**Median**	**IQR**	**Median**	**IQR**
218.0	Uterine fibroid	2.5	2.5	32.5	24.7	3.2	3.2
474.1	Hypertrophy of tonsils and adenoids	2.9	2.9	45.0	21.7	2.9	2.9
715.1	Osteoarthritis (localised and primary)	8.1	19.4	44.0	22.5	3.2	3.2
628.9	Infertility, female of unspec origin	26.9	22.4	36.7	13.3	2.5	2.5
381.2	Chronic mucoid otitis media	37.1	12.9	42.9	12.9	2.8	2.8
381.3	Chronic non-supporative otitis media (other/unspec)	37.5	12.5	44.3	16.2	3.1	3.1
611.7	Signs and symptoms in breast	3.6	9.5	33.3	21.0	38.6	14.3
592.0	Calculus of kidney	17.5	18.1	43.8	19.4	40.8	10.8
530.3	Stricture & stenosis of oesophagus	46.0	24.0	36.7	21.3	45.0	27.5
agree?	424.1, 598.9, 600, 605, 802						
also	511.9, 555.9, 381.4, 626.9, 715.0, 728.6						

Key: '*agree?*' indicates poor consensus (see text); '*also*' indicates fewer than 400 admissions in the North West Thames dataset; bold type indicates marker conditions; IQR, interquartile range; nec, not elsewhere classified; unspec, unspecified; w, with; w/o, without; ACS, ambulatory care sensitive.

Table 11 **Ambulatory care insensitive conditions (Q1<50% and Q2 <50%)**

(a) Little scope for prevention or management in ambulatory care (Q1<30% or Q2 <30%)

		ADMISSION USUALLY URGENT (Q3 =or>70%)					
		Q1		Q2		Q3	
ICD-9 code	Condition	Median	IQR	Median	IQR	Median	IQR
512	**Pneumothorax**	2.5	2.5	2.7	2.7	97.0	3.0
540.9/1	**Acute appendicitis w/o peritonitis or unqualified**	2.7	2.7	2.7	2.7	97.3	2.7
823.2	**Fracture of tibia and fibula, shaft, closed**	2.5	2.5	8.1	19.4	97.2	2.8
560.9	**Intestinal obstruction unspec**	3.6	12.6	15.4	24.9	96.4	9.4
820.8	**Fractured femur unspec, closed**	15.4	18.8	2.5	2.5	97.5	2.5
965.4	**Poisoning by paracetamol. acetanilide, phenacetin**	27.5	31.3	3.2	3.2	97.5	2.5
578.0	**Haematemesis**	28.2	24.4	23.8	26.8	97.5	2.5
813.0	Fracture of radius & ulna (upper, unspec, closed)	3.1	3.1	3.6	9.5	82.5	31.3
Agree?	854						
Also	821.0, 574.5, 426.9, 560.8						

		ADMISSION NOT USUALLY URGENT (Q3 <70%)					
		Q1		Q2		Q3	
ICD-9 code	Condition	Median	IQR	Median	IQR	Median	IQR
366.1	Senile cataract	2.5	2.5	2.5	2.5	2.8	2.8
366.9	Cataract unspec	3.1	3.1	3.1	3.1	2.5	2.5
470	Deflected nasal septum	2.5	2.5	3.6	9.5	2.5	2.5
550.9	Inguinal hernia w/o obstruction/gangrene	3.2	3.2	4.2	15.4	2.8	2.8
627.1	Postmenopausal bleeding	2.5	2.5	4.0	15.5	3.8	12.5
752.5	Undescended testicle	2.5	2.5	3.3	3.3	3.0	3.0
620.2	Ovarian cyst	2.8	2.8	4.5	13.7	21.7	22.1
203.0	Multiple myeloma	2.5	2.5	3.3	3.3	40.9	10.9
599.7	Haematuria	3.0	3.0	17.5	15.0	22.9	22.9

Key: '*agree?*' indicates poor consensus (see text); '*also*' indicates fewer than 400 admissions in the North West Thames dataset; bold type indicates marker conditions; IQR, interquartile range; nec, not elsewhere classified; unspec, unspecified; w, with, w/o, without; ACS, ambulatory care sensitive.

Table 12 gives a cross-classification of the final results for question 1 against question 2, indicating where the panels felt that the opportunities for avoiding admission lay. For 30 (19.3%) of the conditions, at least 70% of admissions were thought to have been avoidable through more timely and effective management, compared to only 2 (1.3%) avoidable through prevention of onset (and for both of these, most admissions were also avoidable through good management).

The final grouping of conditions, and the criteria used to group them, were sent to all panellists for comment. Of the 34 panellists contacted, nine responded. All indicated that they were satisfied with the final groupings except for an ENT surgeon, who was concerned about 'non-suppurative otitis media' (ICD-9 381.3).

Table 12 Numbers of conditions in different groups

Q2: % of admissions avoidable by better management		Q1: % of admissions avoidable by preventing the onset of the condition 0-4%	5-29%	30-49%	50-69%	70% +	TOTAL
0-4%	All	[redacted]	[redacted]	[redacted]	0	0	23
	>95% urgent	[redacted]	[redacted]	[redacted]			
5-29%	All	[redacted]	[redacted]	[redacted]	0	0	8
	>95% urgent	[redacted]	[redacted]	[redacted]			
30-49%	All	[redacted]	[redacted]	[redacted]	2	0	30
50-69%	All	19	13	17	15	0	64
70-94%	All	11	2	4	6	2	25
95% +	All	3	0	1	1	0	5
TOTAL		68	25	36	24	2	155

Key: =potential markers (numbers of actual markers in bold) ; = ACI; = weakly ACS ; = ACS

ACI= Ambulatory care insensitive, ACS = Ambulatory care sensitive

3.3.3 Discussion

(a) Consensus process

In the USA, lists of conditions for which ambulatory care could prevent a hospital admission have typically been drawn up using a literature review and the considered judgement of a few experts (1)(22)(64). This study used a more transparent method of arriving at a consensus, using a modified nominal group technique.

There were some difficulties with the task. The panels were asked to respond on the basis of their own experience of patients admitted to hospital for each condition. Initially some of the hospital consultants had difficulty thinking in terms of their overall experience rather than specific cases. Also, many factors other than the condition itself can influence the preventability of any particular admission (such as age, co-morbidity and social/informal support). By the second meeting, panellists were clearer about the task, although for some the difficulty was not entirely resolved. The meetings helped panellists to focus and summarise their thinking, and in general they thought that the process had been effective in stimulating debate and producing a list of conditions likely to be amenable to ambulatory care.

One difference between this and earlier studies of ACS conditions is the distinction made between effective prevention of onset and effective management of existing disease. This has obvious advantages, but it does lead to some ambiguity when deriving consolidated lists of ACS, or weakly ACS, conditions from two more specific questions. For example if 50% of cases are preventable and 50% treatable on an ambulatory basis, the overall percentage of avoidable admissions could in theory lie anywhere between 50% and 100%. However in this exercise only 2 conditions were considered to be ACS on grounds of preventability alone.

A more general problem in arriving at consensus statements is how to convert a distribution of values into two or more categories. The definitions of ambulatory care sensitive conditions used in this study involved arbitrary cut points (70% and 50% avoidable), and an arbitrary, if undemanding, definition of 'poor' consensus. For conditions with medians in the mid-range, even quite tight distributions can lead to substantial interquartile ranges, but only one condition in the study (transient cerebral ischaemia) had an interquartile range of more than 50%. For all but a handful of others, the ranges were less than 30%.

(b) Validity

What can be said about the validity of the findings? Firstly, the outcome of consensus studies depends on the expertise in the panel and the quality of the evidence (270)(271) they use. This study involved consultants and GPs nominated by peers with an interest in clinical policy, and then self-selected on grounds of their own interest and availability. This was done because a secondary aim was to develop a list which made sense to local clinicians and to raise discussion locally. However, clinicians who participated came from a range of hospitals and practices - urban, suburban and rural, teaching and non-teaching - and most specialties were represented. In this limited sense those participating were reasonably representative - a pattern noted in consensus studies (272).

Second, there were very marked differences between panels in median scores for the different questions and lists of conditions, suggesting that at very least the process had some power to discriminate. Third, although the panellists were not provided with a literature review, the results were supported by the limited evidence available from published empirical studies on the effect of ambulatory care on hospitalisation rates, particularly for asthma (234)(235)(236) and diabetes (242)(273)(274). Fourth, there were many similarities between the results and those of American studies on this subject (see table 5, chapter 2) despite differences in practice between the UK and US and the different methods used to select and group conditions.

If the study were to be repeated, the single greatest improvement would be to have a substantial overlap between the lists considered by each panel, to allow a proper assessment of the reproducability of the consensus development process. The results for the condition mistakenly reviewed by two panels is at least consistent with a reproducible process, but are hardly conclusive evidence of it. Recent studies of a broadly similar consensus process have given kappas ranging from 0.51 (275)(276) to 0.83 (274).

(c) Substantive results

A number of general themes can be identified. The clear view of the panels was that the scope for avoiding admission through better ambulatory care is very substantial. Although ambulatory care was defined in the way outlined above, in the discussions it was clear that most panellists were concerned with the impact of primary care. Furthermore the panellists thought that timely and effective management of existing disease offered far more scope to reduce avoidable admissions than prevention of onset.

In general, GPs and consultants were in good agreement. The GPs were slightly the more positive about the potential for avoiding admissions than the consultants. Possibly, GPs were the more sanguine about the potential of ambulatory care. Alternatively, in spite of instructions to consider the full range of patients currently admitted with each condition, GPs may have been thinking about the patients registered in their practice they have experienced, while consultants may have been thinking about the patients they cared for in hospital. However the small differences involved should not be over-interpreted.

Clearly, the results of this study cannot be regarded as definitive. At best, they may provide a fair reflection of the clinical consensus (or lack of it) at a given point in time, and thus a possible agenda or shortlist for reviews in which clinical consensus is checked against research results, condition by condition. The risk of short-listing without a literature review in this way is that there may be false negatives or positives: conditions that the literature would support as ACS, but which were not shortlisted by the panel on the basis of their own knowledge, or vice versa.

Meanwhile technical and social developments can be expected to alter thresholds for hospital admission one way or another. The value of the approach in improving equity and effectiveness remains to be seen, but if it finds favour more widely in the NHS it will be necessary to rerun the exercise. However, it may be possible in future to produce revised lists on the basis of a much more limited process, given the very limited changes made after the first round.

Other studies have used much shorter lists of conditions such as asthma and diabetes – admissions for these two conditions have been used recently by the NHS Executive as an indicator of the quality of chronic care management, within a wider set of indicators in national performance assessment framework (155). The advantage of the approach in this study, by contrast, is that it involved far more events, and so as a potential indicator of quality of care could be used for smaller areas or shorter periods of time. Also, if the longer list of conditions is used as a basis for routine monitoring of NHS performance, the scope for 'gaming' (ie focusing management attention on indicator conditions, perhaps at the expense of others) is much reduced.

It has been suggested that improvements in primary care may *increase* hospital utilisation (42). Although such a contention remains controversial (44), it is not inconsistent with the hypothesis that good primary care can cost-effectively reduce admission rates for certain types of condition while increasing them for others. Good primary care will improve appropriate access to the NHS and may well increase admission rates for some non-ACS conditions, if cost-effective treatment demands secondary care. The benefits of better access to timely and effective ambulatory, in particular primary, care may lie not necessarily in cost savings for secondary care, but in improved efficiency in the system as a whole.

3.4 Identifying admission groups for subsequent small area analysis

3.4.1 UK-defined 'ACS' and 'marker' admission groups

The study described above identified two groups of ACS conditions (ACS and weakly ACS) and two groups of marker conditions (potential markers and markers). From these a total of 16 groups of admissions for ACS or marker conditions (termed 'admission groups') were defined for potential further study in the small area analysis, based upon:

- whether an ACS or marker condition had been coded on discharge data;
- the extent to which the admission was thought by the panels to be required within 48 hours;
- whether the ICD-9 diagnostic code for the ACS or marker condition was coded in first place in the admission (ie as the main diagnosis), or whether it appeared as a secondary diagnosis;
- whether or not the admission was a readmission (an admission within 28 days of the discharge date of a previous admission).

How the 16 admission groups were defined is shown in table 13 (for ACS conditions) and table 14 (for marker conditions) below.

Table 13 **ACS admission groups for further analysis**

Admission group	Strong ACS^^	Weak ACS^^	Urgency*	Position of diagnostic code in first episode**	Admissions^ or readmissions
1	Yes	Yes	0-100% (Any urgency)	Main	Admissions
2	Yes	Yes	0-100% (Any urgency)	Main or secondary	Admissions
3	Yes	Yes	0-100% (Any urgency)	Main	Readmissions
4	Yes	Yes	0-100% (Any urgency)	Main or secondary	Readmissions
5	Yes	Yes	70% plus (Urgent)	Main	Admissions
6	Yes	Yes	70% plus (Urgent)	Main or secondary	Admissions
7	Yes	Yes	70% plus (Urgent)	Main	Readmissions
8	Yes	Yes	70% plus (Urgent)	Main or secondary	Readmissions
9	Yes	No	0-100% (Any urgency)	Main	Admissions
10	Yes	No	0-100% (Any urgency)	Main	Readmissions
11	Yes	No	70% plus (Urgent)	Main	Admissions
12	Yes	No	70% plus (Urgent)	Main	Readmissions
13	Yes	No	90% plus (Very urgent)	Main	Admissions
14	Yes	Yes	90% plus (Very urgent)	Main	Readmissions

* Indicates the overall response in the final round of questionnaires to question 3: 'Once admission is indicated, should it take place *within 48 hours*?' Responses in the range 0-100% are referred to as 'any urgency', responses of 70% and over are referred to as 'urgent', responses of 90% or more are referred to as 'very urgent'.

** Indicates the position of the ICD-9 diagnostic code recorded on routine hospital episode statistics data. Main' denotes first recorded diagnosis, 'secondary' denotes a secondary diagnosis. A hospital admission for one patient may consist of more than one finished consultant 'episode' (see chapter 4).

^ Admissions here refer to all admissions including readmissions.

^^ 'Strong' and 'weak' ACS conditions are defined as shown in tables 9 and 10.

Table 14 Marker admission groups for further analysis

Admission group	Markers	Potential markers	Urgency*	Position of diagnostic code in first episode**	Admissions^ or readmissions
15	Yes	Yes	90% plus (Very urgent)	Main	Admissions
16	Yes	No	90% plus (Very urgent)	Main	Admissions

* Indicates the overall response in the final round of questionnaires to question 3: 'Once admission is indicated, should it take place *within 48 hours*?' Responses in the range 0-100% are referred to as 'any urgency' responses of 70% and over are referred to as 'urgent', responses of 90% or more are referred to as 'very urgent'.

** Indicates the position of the ICD-9 diagnostic code recorded on routine hospital episode statistics data. 'Main' denotes first recorded diagnosis, 'secondary' denotes a secondary diagnosis. A hospital admission for one patient may consist of more than one finished consultant 'episode' (see chapter 4).

^ Admissions here refer to all admissions including readmissions.

^^ 'Marker' and 'potential marker' conditions are defined as shown in table 11.

4.2 Other admission groups

A further seven admission groups were defined as follows:

- Group 17 - all admissions in surgical specialties;
- Group 18 - all admissions in medical specialties;
- Group 19 - emergency admissions in surgical specialties;
- Group 20 - emergency admissions in medical specialties;
- Group 21 - admissions for conditions selected by Billings *et al* in the US as 'ambulatory care sensitive' (recorded as 'main' diagnosis in the first episode);
- Group 22 - admissions for conditions selected by Billings *et al* in the US as 'ambulatory care sensitive' (recorded as 'main' or 'secondary' diagnosis in the first episode);
- Group 23 - admissions for conditions selected by Billings *et al* as 'markers'.

The rationale for selecting groups 17 to 20 was first, to see if there were significant differences between medical and surgical admissions, for which the rates of admissions across EDs would be higher and subject to less random variation than admissions for ACS conditions and markers (in general medical admissions were thought more likely to be ambulatory care sensitive than surgical, as suggested from the findings shown in tables 9-11 and the literature review (see chapter 2)). Second, it was thought useful to investigate whether or not there were differences between all admissions and emergency admissions, in particular to assess the effect on these of access to general practitioner and hospital facilities. The rationale for selecting groups 21 to 23 was to enable some comparison with the findings made by Billings *et al* (1).

3.5 Conclusion

In this chapter the broad categories of admissions to be excluded from the study were identified and the reasons outlined. A list of ACS and marker conditions was identified using a consensus development method. A total of twenty three 'admission groups' of conditions were identified, potentially to be included in the small area analysis described in chapter 6.

Chapter 4 Data quality: completeness

Chapter 4 Data quality: completeness

Chapter outline

4.1 Introduction

Routinely collected NHS information on inpatient and daycase admissions in NHS hospitals was to be used in the small area analysis. A common set of data is collected in all acute NHS hospitals in England for every patient admitted. These data are available from individual providers, health authorities, regional health authorities or the Department of Health, in what is known as the 'hospital episode statistics' (HES) dataset.

The aim of the study described in this chapter was to investigate the completeness of this dataset, and specifically to identify hospitals in which data on inpatient activity were relatively incomplete in order to exclude them from further analysis. It was thought important to spend time analysing the quality of the main dataset used because there has been widespread criticism of its adequacy for research purposes.

4.2 Methods

Hospital episode statistics (HES) on all inpatient and daycase episodes occurring in acute hospitals within the former North West Thames region for the years 1991/92, 1992/93 and 1993/4 were obtained from the regional Information Department. The region covered an area whose boundary began at the river Thames in central and West London, and ended in Bedfordshire to the North West of the city – an area covering approximately 3.5 million residents.

Some terminology should be clarified here. In HES, inpatient and daycase activity is recorded as 'finished consultant episodes' (FCEs or episodes) rather than discharges or admissions in individual patients. An *episode* is the length of time a patient spends under the care of one particular specialist while an inpatient in hospital. Episodes are recorded by specialty - the specialty is based on the clinical qualifications of the relevant consultant. The period spent in hospital by a patient (an admission) is called a *'provider spell'*. A provider spell (or admission) consists of one or more episodes of care. Information is collected by financial year. The data included inpatient and daycase episodes which had been coded by 'provider code' and 'provider site', by year, and by specialty. A *provider code* identifies either a single provider unit, or, if the provider unit is linked with one or more smaller hospitals, the provider code refers to the group of hospitals, such as is the case for many NHS Trusts. ***Provider 'site'*** identifies individual hospitals. Across the three years a total of 1 925 780 episodes had been recorded, 0.39% of which had no provider coded recorded. An *NHS Trust* is a community or acute facility which had been granted 'trust status' by the Department of Health, allowing it in theory more freedoms and less direct line management from health authorities than other NHS facilities. In 1991 there were a few Trusts in the region under study, but by 1994 most acute and community facilities were NHS Trusts. Primary care facilities were not termed NHS Trusts in the period 1991-94.

Only the large acute general or teaching hospitals (those providing care on-site in most major specialties in 1991-94) in the region were selected for further study. Hospitals which were originally designated as 'special health authorities' between 1991 and 1994, such as the Royal Marsden, the Brompton and Hammersmith Hospitals (all in London), were excluded. This was partly because they were specialist hospitals providing care to patients in one or two specialties and unlikely to admit a patients with a broad range of ACS conditions, and partly because their inpatient activity dataset was known to be relatively incomplete since they only entered the NHS internal market in 1993-94 and had fewer incentives than existing NHS Trusts to improve the completeness of data recording.

For those episodes with a provider code recorded, those providers with the highest number of recorded admissions were selected. Two main difficulties emerged in identifying these providers. First, during the period 1991-4 provider codes and site codes changed for most hospitals, and the names of several hospitals also changed as hospitals became NHS Trusts. Sets of old codes and names and the corresponding new codes and names were obtained from the regional Information Department.

Second, some of the episodes had been assigned a provider or site code which was not exactly the same as that issued by North West Thames regional health authority, although it was similar. For example instead of the correct codes being 'EQM' (provider group code) and '01' (site code), 'EQM01' '1' had been recorded. To ensure the selection of all episodes occurring in each provider, all provider and site codes recorded on the dataset were listed and grouped together where they obviously represented the same hospital or provider group. This was checked with the regional Information Department. This way a list of codes were produced which could be used to identify all episodes occurring in the provider group and hospitals, the provider code refers to the group of hospitals, such as is the case for many NHS Trusts. ***Provider 'site'*** identifies individual hospitals. Across the three years a total of 1 925 780 episodes had been recorded, 0.39% of which had no provider coded recorded. An *NHS Trust* is a community or acute facility which had been granted 'trust status' by the Department of Health, allowing it in theory more freedoms and less direct line management from health authorities than other NHS facilities. In 1991 there were a few Trusts in the region under study, but by 1994 most acute and community facilities were NHS Trusts. Primary care facilities were not termed NHS Trusts in the period 1991-94.

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Nevertheless, 18 acute hospitals with the most activity were selected in this way. Of these, two (St Albans City and Hemel Hempstead) had effectively merged as an NHS Trust and were operating as one hospital on two sites (with one A&E department) and were treated as one hospital. Another two, Barnet and Edgware General Hospital had also formed into one NHS Trust (the Wellhouse NHS Trust) although were still operating as two separate hospitals (each with its own A&E department). Because of difficulty analysing the completeness of their data by hospital rather than by Trust (see below) in this chapter Edgware and Barnet were analysed as one hospital. This left 16 'hospitals' for analysis.

The data for each hospital were investigated in three ways: the number of *duplicate episodes* were identified and excluded; completeness of the *total count* of episodes recorded was identified ; and completeness of data collected in key fields *within each episode* was assessed. The results were used to identify the hospitals with inadequate data, to be excluded from further analysis.

4.2.1 Checking for duplicate episodes

A number of fields of information are collected on HES data, including those in table 15 below.

Episodes having the same data in the following fields within each hospital were identified as duplicate:

- patient ID number (unique to each hospital);
- date of birth (or age);
- spell number;
- episode number;
- spell start date;
- episode start date.

The duplicates were then removed from the HES dataset.

Table 15 Main fields of information collected on HES data

name	description
ADMIDATE	admission date
ADMIMETH	admission method
EPISTART	episode start date
EPIEND	episode end date
EPIDUR	episode duration
EPIORDER	consultant episode number
DISDATE	date of discharge
DISDEST	discharge destination
DOB	date of birth
SPELDUR	spell duration
STARTAGE	age
SEX	sex
ETHNOS	ethnicity
EDCODE	ED code
DIAG01	diagnostic code 1
DIAG02	diagnostic code 2
DIAG03	diagnostic code 3
DIAG04	diagnostic code 4
DIAG05	diagnostic code 5
DIAG06	diagnostic code 6
DIAG07	diagnostic code 7
OPER01	procedure code 1
OPER02	procedure code 2
OPER03	procedure code 3
OPER04	procedure code 4
MAINSPEF	consultant specialty function code
PATID	patient identification number
PRCODE	provider code
SITERET	site code
PROVSPNO	provider spell number
RESHA	HA of residence

4.2.2 Completeness of the total count of activity

To check the total count of activity recorded, the number of episodes recorded on the NWT HES dataset for each of the 16 study hospitals was compared to the corresponding number of episodes recorded on the 'KP70 return' for each of the three study years.

The 'KP70 return' is a manually completed return made by each NHS provider to the Department of Health that summarises the total count of inpatient and daycase activity annually. The KP70 has three parts:

- part 1 shows the total number of episodes carried out in each specialty;
- part 2 shows the total number of episodes for mothers using maternity facilities;
- part 3 shows the total number of episodes of well babies born in hospital.

The relevant part 1 KP70 returns were obtained on diskette from the Department of Health, the part 3 returns were obtained directly from NWT providers.

But before comparisons could be made two difficulties emerged. First, the aim was to assess the completeness of recorded activity in the 16 largest acute *hospitals* in the region. While data were available by individual hospital on the NWT HES database, data were available only for *NHS Trusts* (which might consist of a number of hospitals) on the KP70 returns. During the study period 1991-1994 most hospitals had grouped with smaller ones to form NHS Trusts, each typically comprising one large acute hospital and several small peripheral specialist hospitals or clinics, such as drug rehabilitation units or facilities for care of the elderly, or those with mental illness or mental handicap. Therefore it was necessary to find out which hospitals had become NHS Trusts during 1991-92 to 1993-4, and identify the hospitals which were grouped within each Trust, and their codes. The information was obtained from the NWT Information Department.

However grouping the hospitals into NHS Trusts was not straightforward. This was because many of the peripheral hospitals had changed names and codes over the period, or had closed or merged with another hospital between 1991-94. The picture was particularly confused in London: two teaching hospitals (Charing Cross Hospitals and St Mary's Hospitals) were grouped with many other smaller hospitals, some of which were functioning almost as stand-alone specialist hospitals because they retained their own A&E department. Furthermore, while the hospitals had joined to form NHS Trusts at the beginning of one of the study years, hospitals had closed or merged at different times within the study year. The situation was particularly confused at Charing Cross Hospital, and its subsequent NHS Trust (Riverside NHS Trust): the main hospital site was not operating as a general hospital providing most of the common specialties, because the organisational arrangements of this NHS Trust were so dynamic (which would make calculating the 'hospital access factor' (to be used in the small area analysis) difficult) it was decided to exclude Riverside NHS Trust entirely from further analysis.

It was not possible to check the completeness of data in the 16 study hospitals without including data from their attached peripheral hospitals. This was potentially a problem because it was thought likely that the completeness of coding would be lower in the peripheral hospitals. It was not possible to solve this problem, but it was alleviated by two factors. Many of the peripheral hospitals served patients admitted into psychiatric care or for mental handicap - the specialties which were excluded from this study and in which very few episodes for ACS conditions were recorded. Also many of the peripheral hospitals had closed between 1991-1994 leaving the main acute hospital as the sole hospital in the provider group.

The second problem related to the fact that the small area analysis was to exclude admissions into the specialties of psychiatry, obstetrics (and related specialties), dental medicine, and admissions in two groups of patients - patients aged 75 years and over and well babies born in hospital (see chapter 3). Ideally comparisons of the total count of episodes recorded on the NWT HES dataset and the KP70 return would exclude these admissions as well. It was possible to exclude from the KP70 return the counts for whole specialties - psychiatry, obstetrics, dental medicine and related specialties – but not for patients aged 75 and older.

Excluding episodes in well babies born in hospital also presented a problem. These episodes were identified on the NWT HES database (most were coded under paediatrics, having a date of birth the same as the admission date) and excluded, but they could not be identified separately in the part 1 KP70 return. However they could be identified from the part 3 KP70 return. These were then subtracted from episodes recorded in paediatrics on the part 1 KP70 return, before comparisons were made between HES and the part 1 KP70 figures for paediatrics.

4.2.3 Completeness of specific data fields (within each episode)

Episodes from each of the 16 study hospitals could be identified from the NWT HES database using the relevant provider codes and site codes.

The main data fields of relevance to this project are:

- *date of birth, age and sex* (required in later analyses to exclude patients aged 75 and over, to exclude babies born in hospital and to standardise the admission rates by age and sex);
- *postcode* (to assign the admission to a small area in the subsequent analysis);
- *main diagnosis* (to identify an admission for ACS and marker conditions).

Thus for each hospital, the following fields were analysed for episodes in all specialties (except obstetrics, psychiatry and related specialties, and dental medicine) and in all ages:

- age

The proportion of episodes with no age (or date of birth) recorded were identified. The proportion of episodes with an age over 110 years recorded were also identified and assumed to be invalid.

- sex

The proportion of episodes with no sex recorded was identified.

The following fields were analysed for episodes in patients aged 0-74 years (excluding well babies) in all specialties except obstetrics, psychiatry, dental medicine and related specialties;

- postcode

The proportion with either a missing postcode or an invalid postcode were identified. To check for invalid codes, postcodes recorded in the relevant episodes were checked against the NHS Users Postcode Directory.

- main diagnosis

The proportion with either a missing ICD-9 code or a 'dustbin' ICD-9 code (799.9 or 799) in the field of main diagnosis was identified. The diagnosis code 799 or 799.9 is often entered either when the coding clerk cannot assign clinical codes to the patient discharge, for example because of missing casenotes or if the diagnoses are unclear from the casenotes.

Hospitals were then graded according to the completeness of the total count of activity and the completeness of data fields within each episode. The datasets were examined using Oracle and Excel computer software.

4.3 Results

4.3.1 Duplicate episodes

The HES dataset contained a total of 1,935,780 episodes recorded between 1991/2 and 1993/4. Of these, 7549 (0.39%) had no provider code and were excluded. In the remainder, 29,938 (1.5%) duplicate episodes were identified - over 20, 000 occurring in one of the study hospitals in one year - and removed. 1, 898,293 episodes remained.

4.3.2 The total count of activity

Of the 16 study hospitals, 6 were NHS Trusts with a number of attached hospitals. The number of episodes recorded in each of the 16 study hospitals (plus the episodes recorded in peripheral hospitals in the same NHS Trust) were identified and compared to the KP70 return. The results are shown in table 16 and refer to patients aged under *and* 75 years and over. Data for patients in all specialties and all ages are shown, and the name of the main acute hospital, rather than of the NHS Trust, is given. The number of episodes on the HES dataset divided by the number on the KP70 return is shown in the column HES/KP70 as a percentage.

Table 16 **The number of episodes recorded on HES data compared to the number on the KP70 return, by provider group by year**

Provider group	Year	Episodes	KP70	HES/KP70 %
Ashford Hospitals	91	20341	18159	112.0
	92	19690	21470	91.7
	93	20015	*	*
Bedford Hospitals	91	30102	29764	101.1
	92	30929	32118	96.3
	93	33838	35108	96.4
Central Middlesex Hospitals	91	28036	27998	100.1
	92	26560	28832	92.1
	93	28907	26155	110.5
Ealing Hospital	91	24669	25189	97.9
	92	22076	26145	84.4
	93	25896	27627	93.7
Hillingdon Hospitals	91	28584	29999	95.3
	92	29674	29288	101.3
	93	32373	32365	100.0
Lister Hospitals	91	40416	34733	116.4
	92	44825	35736	125.4
	93	53126	38614	137.6
Luton & Dunstable Hospitals	91	30206	41970	72.0
	92	31487	43251	72.8
	93	43969	45594	96.4
Mount Vernon Hospitals	91	20616	19416	106.2
	92	22681	22625	100.2
	93	24659	24636	100.1
Northwick Park Hospitals	91	40292	38094	105.8
	92	39728	39402	100.8
	93	38916	38760	100.4
QE2 Hospitals**	91	28903	30738	94.0
	92	30457	30157	101.0
	93	32565	32268	100.9
Charing Cross Hospitals**	91	62457	59470	105.0
	92	73472	64741	113.5
	93	59736	59393	100.6
St Albans City and Hemel Hempstead Hospitals*	91	29722	28564	104.1
	92	30745	30851	99.7
	93	33571	31800	105.6

Table 16 Continued

Provider group	Year	Episodes	KP70	HES/KP70 %
St Mary's Hospitals**	91	62208	55903	111.3
	92	53536	55238	96.9
	93	67763	57033	118.8
West Middlesex Hospitals	91	29869	30155	99.1
	92	30750	30598	100.5
	93	31373	29935	104.8
Watford Hospitals**	91	31254	31718	98.5
	92	32691	32347	101.1
	93	32995	36387	90.7
Edgware & Barnet Hospitals**	91	49388	52304	94.4
	92	51657	49957	103.4
	93	51471	50310	102.3
Total		**1739234**		

* No KP 70 data were available for Ashford hospital in 1992/3 and 1993/4

** Indicates where more than one hospital shared the same NHS Trust provider code.

The table shows that a total of 1,739,234 episodes were recorded in the 16 main acute hospitals in NWT - over 92% of the total recorded in the region. There were discrepancies between HES and KP70 returns across most hospitals and across years, although for many hospitals the differences were less than 5%. However discrepancies between HES and the KP70 returns were sometimes larger in individual specialties. Typically, but not always, the number of episodes recorded on HES was lower than recorded on the KP70 returns. Space does not permit a table showing comparisons by specialty in all hospitals and in all three study years. However a fairly typical example is shown in table 17.

Table 17 **The number of episodes recorded on HES data compared to the number on the KP70 return in Luton and Dunstable Hospitals, by specialty, 1991-92**

Specialty	No episodes on NWT dataset	No episodes on KP70 return	HES/KP70 (%)
General surgery	3414	3446	99.1
Urology	1793	1804	99.4
Trauma and orthopaedics	2398	2422	99.0
Ear, nose throat	1756	1722	99.1
Ophthalmology	1536	1550	99.1
Plastic surgery	3	0	-
Paediatric surgery	278	282	98.6
Accident and emergency	410	421	97.4
Anaesthetics	328	331	99.1
General medicine	6309	6372	99.0
Dermatology	35	36	97.2
Medical oncology	138	139	99.2
Neurology	47	47	100
Paediatrics	3127	7988	39.1
Geriatric medicine	3158	3193	98.9
Gynaecology	3615	3648	99.1
General pathology	1	0	-
Haematology	83	85	97.6

Over all specialties, 72% of episodes on the HES dataset were recorded in the KP70 return in 1991-92. But as seen in table 17 most of the discrepancy occurred in paediatrics, and other excluded specialties (not shown here) such as psychiatry, obstetrics, dental medicine and related specialties. This is an important observation because ACS and marker conditions were mainly recorded in specialties in which the discrepancy was relatively small.

Of the specialties in which episodes for ACS and marker conditions occurred, the discrepancies were particularly wide (>10%) in some years in 7 providers in paediatrics (code 420), as shown in the example above. A problem was that it was not possible to be confident that the number of episodes in well babies had been excluded from both the HES data and the part 1 KP70 return because the number on the part 3 KP70 return often bore no relation to the number identified on the HES data. In some providers, there were wide discrepancies in paediatrics in all three years. On discussion with information officers in these providers, the likely explanation was that the episodes of well babies born in hospital were often recorded on separate maternity information systems and inadequately transferred to HES, and vice versa. Depending upon the source material used to compile the part 3 KP70 return, the return could easily over- or underestimate the number of episodes for these babies. In other providers there was a marked discrepancy in one particular year, and the explanation given was that there had been a problem transferring information from the maternity information system to the main hospital information system typically because the hospital IT system had been upgraded or replaced in that particular year. The consequence relevant to this study is that it is therefore not possible to make reliable comparisons of the total count of activity in paediatrics between HES and the KP70 return for these 7 providers.

Finally, in four providers there were also major discrepancies between HES and the KP70 in the specialty of gynaecology. Again, discussion with the information officers in each provider revealed that the likely explanation for this was that episodes in this specialty were often recorded on the maternity information system (when gynaecological conditions were treated in maternity patients) and incompletely transferred to the hospital's main HES database. Thus for similar reasons to paediatrics, it was not possible to obtain an accurate picture of the completeness of the activity recorded in gynaecology.

To be more confident about the completeness of the count of activity in specialties in which ACS episodes were recorded, the number of episodes with a main diagnosis of an ACS condition (in patients aged under 75 years and excluding well babies) was identified from the NWT HES database by hospital and specialty. Then the proportion of the ACS episodes occurring in specialties with less than a 10% discrepancy between the HES data and the KP70 return was identified. The results are shown in table 18 below. In the table, the seven providers in which there were marked discrepancies with paediatrics in one or more of the study years are identified. For these providers the figures in brackets in the third column are the findings excluding paediatrics in the years in which activity on HES and KP70 showed the greatest discrepancy. A similar calculation was not made by excluding gynaecology because the proportion of ACS episodes occurring in the specialty was very small.

Table 18 **The percentage of ACS episodes within specialties in which less than a 10% discrepancy was observed between HES and the part 1 KP70 return, in 16 acute providers in NWT, 1991-94***

Provider group	Year	% of ACS episodes including paediatrics	excluding paediatrics
Ashford^	912	99.3	
	923	87.6	100
	934	KP70 data not available	
Bedford	912	90.7	
	923	99.6	
	934	100	
Cental Middlesex	912	100	
	923	99.7	
	934	53.3	
Charing Cross	912	96.0	
	923	92.6	
	934	82.0	
Ealing^	912	84.4	100
	923	78.1	99.9
	934	84.5	99.4
Edgware and Barnet^	912	99.9	
	923	69.8	83.5
	934	99.9	
Hemel Hempstead & St Albans^	912	83.6	99.2
	923	66.4	87.2
	934	86.4	95.5
Hillingdon^	912	99.1	100
	923	99.4	
	934	99.9	
Lister	912	99.5	
	923	99.2	
	934	99.5	
Luton & Dunstable^	912	83.9	100
	923	84.5	100
	934	86.2	100
Mt Vernon	912	93.8	
	923	84.9	
	934	100	

Table 18 Continued

Provider group	Year	% of ACS episodes including paediatrics	excluding paediatrics
Northwick Park	912	98.7	
	923	99.6	
	934	99.9	
QE2^	912	89.5	100
	923	100	
	934	100	
St Mary's	912	78.4	
	923	55	
	934	92.9	
West Middlesex	912	99.9	
	923	100	
	934	99.8	
Watford	912	100	
	923	99.1	
	934	98.7	

* Less than 100% indicates that there were fewer episodes recorded on HES than the KP70.
^ Providers in which there were marked discrepancies between HES and KP70 (>10%) in paediatrics.

The table shows that, in most hospitals, over 90% of ACS episodes were recorded in specialties with less than a 10% discrepancy between HES and the KP70 return.

4.3.3 Completeness of specific data fields

Table 19 shows the percentage of missing or invalid data in each episode found in the fields of date of birth, age, sex, postcode, and main diagnosis for each of the 16 main hospitals.

Table 19	The proportion of missing or invalid data in each episode found in the data fields: date of birth; age; sex; postcode; and main diagnosis, by provider, 1991-94.

Hospital	Year	Date of Birth^	Age^ (%)	Sex^ (%)	Postcode* (%)	Main* diagnosis
Ashford	912	0	0	0	0.4	3.5
	923	0	0	0	1	1.1
	934	0.09	0	0	0.9	0.71
Bedford	912	0.08	0	0	0.6	11.3
	923	0.04	0	0	0.5	3.5
	934	0.03	0	0	2.8	6.5
Cental Middlesex	912	0.15	7	0	2.5	31.4
	923	0.14	21	0	0.9	27
	934	0.13	25	0	1.3	18.7
Charing Cross	912	0.13	0	0	0.8	11.8
	923	0.03	0	0	1.4	14.5
	934	0.03	0	0	0.7	7.6
Ealing	912	0.09	0	0	1.2	9
	923	0	1	0	2.3	6.1
	934	0	0	0	1.2	1.73
Edgware and Barnet	912	0.22	0	0	0.3	0.2
	923	0.23	0	0	0	6
	934	0.22	0	0	0.1	2.62
Hemel Hempstead & St Albans	912	0.01	0	0	1.2	2.9
	923	0.01	0	0	0.8	0.01
	934	2.78	0	2.78	0.8	1.09
Hillingdon	912	0.09	0	0	1.1	0.9
	923	0.11	0	0.02	0.9	1.1
	934	0.06	0	0.19	1.3	2.19
Lister	912	0	0	0	0	2.6
	923	0	0	0	0	0.1
	934	0	0	0	0.1	0.23
Luton & Dunstable	912	2.11	0	0	1.9	0.6
	923	1.79	0	0	3.6	2.1
	934	0	0	0	1.8	7.91
Mt Vernon	912	0.16	0	0	0.7	0.3
	923	0.04	0	0	0.6	0.3
	934	0.25	0	0	0.2	0.1
Northwick Park	912	0	0	0	1.4	0.5
	923	0.01	0	0.02	0.4	4.9
	934	0.02	0	0.19	0.4	0.2
QE2	912	0.01	0	0	0.5	1.1
	923	0	0	0	0.3	0.7
	934	0.01	0	0	0.1	1.46
St Mary's	912	0.07	0	0	5.3	18.2
	923	0.08	0	0	2.1	19.2
	934	0	0	0	4.5	2.7
West Middlesex	912	0.01	0	0	0.1	19.3
	923	0	3.0	0	0	21.7
	934	0.02	0	0	0.1	1.11

Table 19 Continued

Hospital	Year	Date of Birth^	Age^ (%)	Sex^ (%)	Postcode* (%)	Main* diagnosis (%)
Watford	912	0.05	0	0	0.4	10.3
	923	0.02	0	0	0.5	10.4
	934	0.02	0	0	0.3	0

^ results refer to episodes in all ages and all specialties.
* results exclude episodes occurring in the following: patients aged 75 years or older; well babies born in hospital; psychiatry, obstetrics, dental medicine and related specialties.

The table shows that in most hospitals, data recording the fields of date of birth or age, sex and postcode was fairly complete, and valid (using the rudimentary tests for validity as described in the methods). The completeness of postcoding was lowest in St Mary's Hospitals. However there were significant gaps in the recording of main diagnosis: six hospitals had greater than 10% of episodes uncoded for main diagnosis in at least one year, and one hospital (Central Middlesex) had more than 30% uncoded.

4.4 Identifying hospitals to be excluded from further analysis

From the results shown above, incomplete data recording appeared to be most problematic in the following areas: the total count of activity in specialties in which ACS conditions had been recorded; and the fields with each episode for main diagnosis and postcode.

Some criteria were developed for excluding hospitals from the small area analysis. It was decided that hospitals should be excluded from the small area analysis if there was a discrepancy of 10% or more between HES and KP70 in specialties in which 90% of ACS conditions were recorded (see table 18). For providers in which a wide discrepancy in paediatrics had been noted in particular years, the criterion applied to all specialties except paediatrics in the relevant year. It was further decided that hospitals in which 5% or more episodes had missing or invalid data in the fields of postcode, main diagnosis, age or date of birth and sex (see table 19) should be excluded. The hospitals meeting the relevant criteria or not in each year are shown in the table below – the bold type indicates those meeting the criteria.

Table 20 **Hospitals meeting the relevant criteria for data quality, 1991-4**

Provider group	Year	HES/KP70* <=10%? (Y/N)	Key episode^ fields <=5%? (Y/N)	Included in small area analysis?
Ashford	912	Y	Y	Y
	923	Y	Y	Y
	934	Y	Y	Y
Bedford	912	Y	N	N
	923	Y	Y	Y
	934	Y	N	N
Cental Middlesex	912	Y	N	N
	923	Y	N	N
	934	N	N	N
Charing Cross	912	Y	N	N
	923	Y	N	N
	93	N	N	N
Ealing	912	Y	N	N
	923	Y	N	N
	934	Y	Y	Y
Edgware and Barnet	91	Y	Y	Y
	923	N	N	N
	934	Y	Y	Y
Hemel Hempstead & St Albans	912	Y	Y	Y
	923	N	Y	N
	934	Y	Y	Y
Hillingdon	912	Y	Y	Y
	923	Y	Y	Y
	934	Y	Y	Y
Lister	912	Y	Y	Y
	923	Y	Y	Y
	934	Y	Y	Y
Luton & Dunstable	912	Y	Y	Y
	923	Y	Y	Y
	934	Y	N	N
Mt Vernon	912	Y	Y	Y
	923	N	Y	N
	934	Y	Y	Y
Northwick Park	912	Y	Y	Y
	923	Y	Y	Y
	934	Y	Y	Y
QE2	912	Y	Y	Y
	923	Y	Y	Y
	934	Y	Y	Y
St Mary's	912	N	N	N
	923	N	N	N
	934	Y	Y	Y
West Middlesex	912	Y	N	N
	923	Y	N	N
	934	Y	Y	Y

Table 20 Continued

Provider group	Year	HES/KP70* <=10%? (Y/N)	Key episode^ fields <=5%? (Y/N)	Included in small area analysis?
Watford	912	Y	N	N
	923	Y	N	N
	934	Y	Y	Y

*this column refers to where 90% or more ACS episodes occurred in specialties with less than a 10% discrepancy between the HES data and the KP70 return

^ this column refers to where less than 5% of episodes examined had incomplete data in the fields of date of birth or age, sex, postcode, and main diagnosis.

Using these criteria 28 'hospital-years' of data out of a total of 48 remained, as shown, for he small area analysis.

4.5 Discussion

The main aim of the analysis presented here was to gauge the completeness of some of the data recorded on the NWT HES dataset in the 16 largest acute providers, and to exclude from subsequent investigation providers with the most incomplete data.

The study has several limitations with regard to the small area analysis. First, for simplicity, episodes rather than admissions were analysed - admission rates are to be analysed in the small area analysis. However over 90% of admissions in the NWT dataset consisted of only one episode.

Second, the data also included episodes occurring in *non-NWT* residents within the study hospitals (data which would not be used in the later analysis). Episodes in non-NWT patients may have been atypical, for example in patients who could have been transferred into NWT providers because of being more complex cases. However, as discussed with the NWTRHA Information Department, they are more likely to represent patients living across the boundary in neighbouring regions and to be typical cases. In either case it is not clear whether the completeness of data recording would be systematically different in these cases.

Third, the analysis did not include episodes of NWT residents occurring in other hospitals within or outside the region, unless they were grouped with the 16 hospitals within NHS Trusts.

Fourth, part of the analysis compared the completeness of activity recorded on HES with that recorded on the KP70 return. The KP70 figures are not a 'gold standard' measure but are the only available standard against which to assess completeness of recorded activity. However since they are compiled from the hospital's own information systems - the same as HES - a question arises of which source of data is the most reliable estimate of activity, and whether discrepancies really indicate a problem of completeness. There may be several 'legitimate' reasons for differences. For example KP70 returns include unfinished episodes (for example patients still in hospital) as well as finished episodes, whereas HES data only includes finished episodes. HES data for each financial year is often submitted later than the KP70 return, allowing more fully coded episodes to be recorded on HES. Where the KP70 figures were lower than the HES data, this could be because: the KP70s were returned before all HES data for the year were completely coded; of errors in manual returns; and because of ambiguity in the criteria for collecting data for KP70. Where the KP70 was higher, this could be because of incomplete HES data. Despite the knowledge that KP70 was not a 'gold standard' estimate - in this study it was decided that discrepancies with HES, in either direction, were likely to indicate problems with the completeness of data recording.

Finally the checks on validity of the data recorded within each episode were somewhat crude. For example episodes with missing data, or 'dustbin' ICD-9 codes (799, 799.9), only were identified for the field of main diagnosis. More sophisticated analysis would have used algorithms to assess the validity of the main diagnosis, for example checking whether gynaecological conditions occurred in men.

Nevertheless there were several useful results. Despite the large amount of resources used to upgrade information systems in providers during 1991-94, it is perhaps surprising that so many duplicate episodes were identified. The information officers in the hospital in which 20 000 episodes were duplicated in one year suggested this had occurred because of moving over to a new hospital information system during the year in question.

The study highlighted that there may be significant under-recording of activity on HES data in maternity specialties, gynaecology and paediatrics.

Perhaps a more worrying finding was the high proportion of episodes without a main diagnosis recorded (or having a 'dustbin' ICD-9 code) in some hospitals, in particular the Central Middlesex Hospital. This may reflect the low priority clinical coding is afforded in many hospitals, possibly because the income of providers in 1991-94 was less dependent upon the accuracy of diagnostic coding than on the accuracy of coding by specialty.

The criteria chosen to exclude some of the hospitals from further analysis were to a large extent arbitrary. They represented a compromise between a desire to include only hospitals with almost totally complete data, and wanting to keep a substantial number of hospitals for analysis. Nevertheless, out of a possible 48 hospital-years of data, 20 were excluded using these criteria.

One issue to be resolved was whether to include in the small area analysis the ACS conditions which were likely to be recorded in the specialities of paediatrics and gynaecology, in view of the large discrepancies between the HES data and KP70 in these specialties. For paediatrics, the problem appeared to be because episodes in well babies born in hospital were inconsistently recorded on HES data. Furthermore the number of ACS conditions identified in chapter 3 which could potentially be recorded in paediatrics, and the proportion of ACS conditions actually found to have been recorded on HES data, were sizeable. For these reasons it was decided not to exclude episodes in paediatrics from the subsequent analysis. For gynaecology, fewer gynaecological conditions had been found to be ACS, and, as noted in chapter 3, several of the panellists were unhappy with classifying these conditions because they were often symptoms which could apply to several conditions. (for example 'irregular menstrual bleeding' or 'excessive menses'). The proportion of ACS episodes recorded in gynaecology was found to be small, although this could have been because of incomplete transfer of information from the hospital's maternity information system. For these reasons it was decided to exclude all episodes recorded in gynaecology from subsequent analysis.

4.6 Summary and conclusion

Complicated though the investigation was in this chapter, it uncovered findings that were important to take note of in the small area analysis.

The total count of activity in the 16 study hospitals, and the coding of age or date of birth, sex and postcode were relatively completely recorded on HES data. A larger proportion of episodes had missing or invalid coding for main diagnosis. Hospitals were excluded for further study if there was a discrepancy of 10% or more between HES and KP70 in specialties in which 90% of ACS conditions were recorded, and in which 5% or greater episodes had missing or invalid data in the fields of postcode, main diagnosis, age or date of birth and sex.

20 out of a total 48 possible hospital-years of data were excluded using these criteria. Finally, it was decided that episodes or admissions recorded in the specialty of gynaecology were to be excluded from further analysis.

The investigation in this chapter largely focused on the completeness of data recorded. An evaluation of the quality of diagnostic coding of admissions on HES data is described in the next chapter.

Chapter 5 Investigating the accuracy of diagnostic coding of routinely collected hospital admissions data

Chapter outline

5.1 Introduction

Having accurate diagnostic information for hospital activity in the NHS is crucial to this study. While the volume of recorded inpatient and day case activity is regularly analysed (277), little is known about the accuracy of clinical coding in routine data, despite the substantial cost to the NHS of collecting them.

The few studies in this area have estimated the 'accuracy' of clinical coding to be between 60-90% (278)(279)(280)(281)(282)(283). Strictly, most of these studies have been concerned with *reproducibility* of the coding process rather than with accuracy of the diagnostic codes, the question at issue being whether different coders, given the same set of medical records, register the same set of codes, rather than involving independent clinical review of patients or test results (284). But interpretation of these studies is difficult because experienced clinical coders have generally not been used to review codes (285)(286) and the reviewers used were often not blind to the original codes recorded. Furthermore, the studies were of data collected before the study period of 1991-94 when the incentives for collecting accurate data were different and hospital information systems less sophisticated.

This study set out to address these methodological issues by using experienced clinical coders who were unaware of the original codes recorded, and by examining inpatient data collected after 1991.

5.2 Methods

5.2.1 Selection of hospitals

Funding was available to conduct the study in only two hospitals in the NHS region under study - the former North West Thames region. The hospitals chosen - Lister and Luton & Dunstable Hospital were large acute NHS Trusts typical of those serving non-metropolitan areas and which had been selected in chapter 4 for inclusion in the small area analysis.

5.2.2 Selection of case notes

Routine hospital episode statistics were obtained from the hospitals for patients discharged between April 1991 and January 1993, the most recent data at the time of the study. 'Finished consultant episodes' of care were grouped to represent hospital admissions. However Luton & Dunstable Hospital only supplied clinical codes relating to the first episode in each admission, and so these only were used for both hospitals. Hospital admissions in several broad admission groups (referred to in chapter 3 and 4) were also excluded.

From the remaining first episodes (37,192 at Lister Hospital, 39,679 at Luton & Dunstable Hospital) five random samples were selected for each hospital:

- *a 'general' group* containing a random selection of any diagnoses (target: n=385);
- *two 'disease-specific' groups representing ACS conditions*: asthma (target: n = 165), diabetes (target: n = 165);
- *two 'disease specific' groups representing 'marker' conditions*: fractured femur (target: n = 85) and appendicitis with appendicectomy (target: n = 85).

The 'general' group was chosen in order to give a general picture as to the reproducibility of clinical coding across a range of diagnoses - including ACS and marker conditions. At the time the study started, the full range of ACS and marker conditions had not been fully identified from the study described in chapter 3. Disease-specific groups of admissions for one or two ACS and marker conditions were chosen to allow a more in depth analysis of coding of two common ACS and marker conditions. The total sample size was 885 for each hospital. In each group, half the sample was drawn from 1991/2 and half from 1992/3 (the most recent data available at the time of the study). In each of the four disease-specific groups, half the sample was drawn with the diagnosis coded as the *main* diagnosis (in coding regulations this is the diagnosis which was the reason why the patient was admitted) and half as a *secondary* diagnosis within the first finished consultant episode. In the 'general' group' approximately 2% of the sample drawn in each hospital had no clinical codes assigned. In these cases the local coders were asked to code the admissions as usual.

5.2.3 Recoding

Four clinical coders from a private company - CASPE Healthcare Knowledge Systems (CHKS) - were employed as the external coders. All were experienced and had worked for several years in the NHS as coders, and three had trained other NHS coders.

For each episode, these 'external' coders could record up to 7 diagnoses (using ICD-9 codes) (268), and up to 4 procedures (using OPCS-4 codes (287)). The external coders used the same source material (case notes) as the local coders, and both used the national rules used in the NHS for clinical coding (288)(289). To help coders identify each episode in the casenotes, information was provided showing the specialty, start and end date of each finished consultant episode of care.

Where local and external coders disagreed, the casenotes were reviewed by the most senior coding manager at North West Thames Regional Health Authority. All coders were unaware of codes recorded by others.

5.2.4 Analysis

Agreement between external and local coders was identified at two levels: *exact* agreement over the main diagnosis (or main procedure); and *approximate* agreement (based on the first 3-digits of the ICD-9 code for diagnosis, and the letter and first 2-digits of the OPCS-4 code for procedure).

Kappa statistics were calculated for the 'general' groups, but not for the disease-specific groups because these did not provide a full 'square' design: for example, there were no data on the numbers of cases which were not coded as asthma by the local coders, but would have been coded as such by the external coders. Percentage agreement was calculated for all groups, with 95% confidence intervals for levels of approximate agreement. The sequencing of codes was also compared.

5.3 Results

5.3.1 Retrieval

Of the 885 discharges chosen in each hospital, the case notes of 804 were found in Lister Hospital (90.8%) and 803 (90.7%) in Luton & Dunstable Hospital.

5.3.2 Diagnostic codes

The level of agreement (expressed as the percentage agreement between the external and local coders over the codes for main diagnosis) is shown in columns (a) and (b) in table 21.

Table 21 Percentage agreement by external coders over the main diagnosis and main procedure codes as identified by local coders

		Local main code same as external code		Local main code same as external secondary code		Local main code not recorded by externals	
Group		Exact*	Approximate**	Exact*	Approximate**	Exact*	Approximate**
	Hospital	(a)	(b)	(a)	(b)	(a)	(b)
General	A	43	55 (50.5-61.2)	5	7	52	38
	B	60	72 (66.8-76.4)	5	8	35	20
Asthma^	A	35	86 (75.3-92.3)	3	4	62	10
	B	53	91 (81.1-95.9)	4	6	43	3
Diabetes^	A	6	70 (58.3-86.2)	13	25	81	5
	B	9	75 (63.8-88.4)	13	22	78	3
Appendicitis^	A	51	78 (72.7-90.9)	3	6	46	16
	B	65	80 (68.8-88.4)	1	1	34	19
Fractured femur^	A	47	84 (72.7-90.9)	4	4	49	12
	B	30	89 (73.6-96.5)	0	0	70	11
Main procedure	A	52	73 (65.9-78.3)	7	8	41	19
	B	69	82 (75.3-86.4)	4	4	27	14

The 95 per cent confidence intervals are shown in parentheses
* For diagnoses: identical ICD-9 four-digit codes; for procedures: identical OPCS codes
** For diagnoses: first three digits of ICD codes identical; for procedures: the first two characters of the OPCS codes identical.
^ Result shown in these disease- specific groups are for where the disease was locally coded as the main diagnosis.

Column (a) shows that, in the 'general' group, the *exact* agreement over the code for main diagnosis was 43% at Lister Hospital and 60% at Luton & Dunstable Hospital. Agreement was slightly higher for fractured femur and appendicitis but the possibility of chance agreement was greatest in these groups because fewer categories were involved. Exact agreement was very low for diabetes. Column (b) shows that *approximate* agreement was higher for all groups, as expected, and very good for asthma (agreement of 86% and 91% in the two hospitals) and fractured femur. Kappa values for the 'general' groups were 0.54 for Lister Hospital, and 0.72 for Luton & Dunstable Hospital. These values are very close to the percentage agreement because, given the large number of categories used and reasonably even spread of observations across them, the probability of chance agreement was small. This improvement in reproducibility was striking for diabetes; the local coders in both hospitals differed from the external coders in their use of the fourth digit of the ICD-9 code.

Procedure codes were investigated for first episodes in the 'general' groups. The figures in the last two rows of table 21 refer to records in which both sets of coders had recorded at least one procedure in the first episode. Disagreement about whether a particular procedure was the main or a secondary one was relatively uncommon.

A second analysis was done including all records in the 'general' groups. In this analysis, if neither coder recorded a particular procedure, this counted as an agreement; if one did and the other did not, this was a disagreement. For Lister Hospital, there was exact agreement for 58% and approximate agreement for 70% (kappa = 0.66). For Luton & Dunstable Hospital, the corresponding figures were 76% and 83% (kappa = 0.80). The adjustment involved in the kappa statistic related almost entirely to the possibility of chance agreements that there had been no procedure.

To identify how far disagreements in diagnostic codes were due to differences in *sequencing* of codes, we investigated whether the main diagnosis recorded by the local coders had been recorded by the external coders as a secondary diagnosis instead. The results are shown in table 21 in columns (c) and (d). For the 'general' group from Lister Hospital, the locally-coded exact main diagnosis was identified as a secondary diagnosis by the external coders in 5% of cases, but in 52% it appeared nowhere on the externally coded list of diagnoses. The results were similar for the other disease groups at Lister Hospital except for diabetes, where the proportion recorded as a secondary diagnosis by the external coders was higher. The results for Luton & Dunstable Hospital were also similar. In general, therefore, disagreements in coding did not appear to be due to sequencing differences. The external coders tended to code more secondary diagnoses or comorbidities than the local coders in both hospitals, especially for chronic conditions like diabetes.

Where there was not even approximate agreement over the main diagnosis, the disagreements fell into the following five broad categories:

(1) where one group of coders had recorded a symptom, and the other had recorded a diagnosis; related to the symptom; eg abdominal pain (ICD-9 code 789.0) and acute appendicitis (540.9);

(2) where both coders had recorded codes for very similar if not identical conditions, often where one code was more precise than the other; eg diabetes (250.0) and diabetes in pregnancy (648.0); acute appendix (540.9) and appendix unqualified (541); pneumonia (486) and pneumococcal pneumonia (481);

(3) where there was obvious disagreement between coders over similar conditions; eg acute appendicitis (540.9) and mesenteric lymphadenitis (289.2), chronic tonsillitis (474.0) and acute tonsillitis (463); emphysema (492) and asthma (493.9);

(4) where coders had recorded codes for conditions which were not similar but obviously related; eg diabetes (250.0) and cellulitis (682.7), phlebitis of the deep vessels of the lower extremities (415.1) and pulmonary embolus (451.1);

(5) where coders had recorded completely different conditions; eg bronchopneumonia (485) and fracture of the vault of the skull (800.1);

(X) where external coders were not able to reach a decision and had not recorded a main diagnosis.

The proportion of disagreements in each category at each hospital is shown in table 22; the disagreements were spread evenly across all categories in both hospitals, but the proportion of cases in category X was lower at Luton & Dunstable Hospital.

Table 22 The proportion of cases in each category* as a percentage of all disagreements (where external and local coders did not agree over the first three digits of the ICD-9 code for main diagnosis) and as a percentage of all cases reviewed

	Hospital A		Hospital B	
Category	% of disagreements (n= 295)	% of all cases reviewed (n=804)	% of disagreements (n=213)	% of all cases reviewed (n=803)
1	13.6	5.0	19.1	5.1
2	17.6	6.5	11.2	3.0
3	23.4	8.6	29.3	7.7
4	10.5	3.8	15.8	4.2
5	18.3	6.7	19.5	5.2
X	16.6	6.1	5.1	1.2
Total	100	36.7	100	26.4

The results are shown for all disease groups combined.

* For a description of categories, see text.

For all disease groups together, the level of exact agreement over the main diagnosis increased between 1991/2 and 1992/3 from 38% to 42% at Lister Hospital and from 68% to 79% at Luton & Dunstable Hospital. The increase was statistically significant for Luton & Dunstable Hospital only ($p<0.05$).

Table 23 shows how the external coders coded asthma and diabetes where local coders had recorded these as secondary diagnoses. In most cases both sets of coders agreed that the diabetes and asthma were secondary diagnoses. However, for asthma, the external coders thought that in 17% (Lister Hospital) and 18% (Luton & Dunstable Hospital) of cases, this was the main, rather than the secondary diagnosis. Also the external coders had not coded asthma at all in 9% (in Lister Hospital) and 14% (Luton & Dunstable Hospital) of discharges in this group.

Table 23 **Percentage agreement between external coders and local coders over asthma and diabetes when these were coded by local coders as secondary diagnoses; for disagreements, the percentage of cases where the external coders had recorded asthma or diabetes as a main diagnosis or not at all**

	Agreement	Disagreement		
	Secondary diagnosis (3-digit ICD-9 code) %)	ain diagnosis (3-digit ICD-9 code) (%)	Not coded (3-digit ICD-9 code) (%)	n
Hospital A				
Disease group				
Asthma	74 (62.4-83.0)	17 (9.7-27.7)	9 (3.9-18.3)	76
Diabetes	88 (78.1-94.0)	7 (2.7-15.9)	5 (1.56-13.3)	76
Hospital B				
Disease group				
Asthma	68 (55.9-78.3)	18 (0.3-29.9)	14 (7.3-24.7)	72
Diabetes	92 (83.4-96.6)	4 (1.1-11.4)	4 (1.1-11.4)	83

The fractured femur and appendicitis (with appendicetomy) groups are omitted because of small numbers.
95% confidence intervals are shown in parentheses.

5.3.3 Review by the regional coder

Table 24 shows that where there was not even approximate agreement over main diagnosis, the third coder disagreed with both local and external coders in a high proportion of cases, but more so with the local than with the external coders. The differences were statistically significant ($p<0.05$) at Lister Hospital but not at Luton & Dunstable Hospital.

Table 24 **The percentage agreement on the main diagnosis (on the first three digits of the ICD-9 code) between the regional coder and the local coders and external coders**

	Agreement of regional coder with:			
	Local coders	External coders	Neither	n
Hospital A	17(13.0-21.9)	30(24.9-35.6)	53 (47.1-58.8)	295
Hospital B	27(21.3-33.6)	38 (31.4-44.9)	35 (28.7-41.9)	213

The 95% confidence intervals are shown in parentheses.

5.4 Discussion

The *accuracy* of clinical codes depends upon how closely they reflect the clinical condition of the relevant patient, (path A in figure 4). However this study involved comparison of two sets of codes independently abstracted from the casenotes (path B in figure 4), and is thus a study of the reproducability of the coding process.

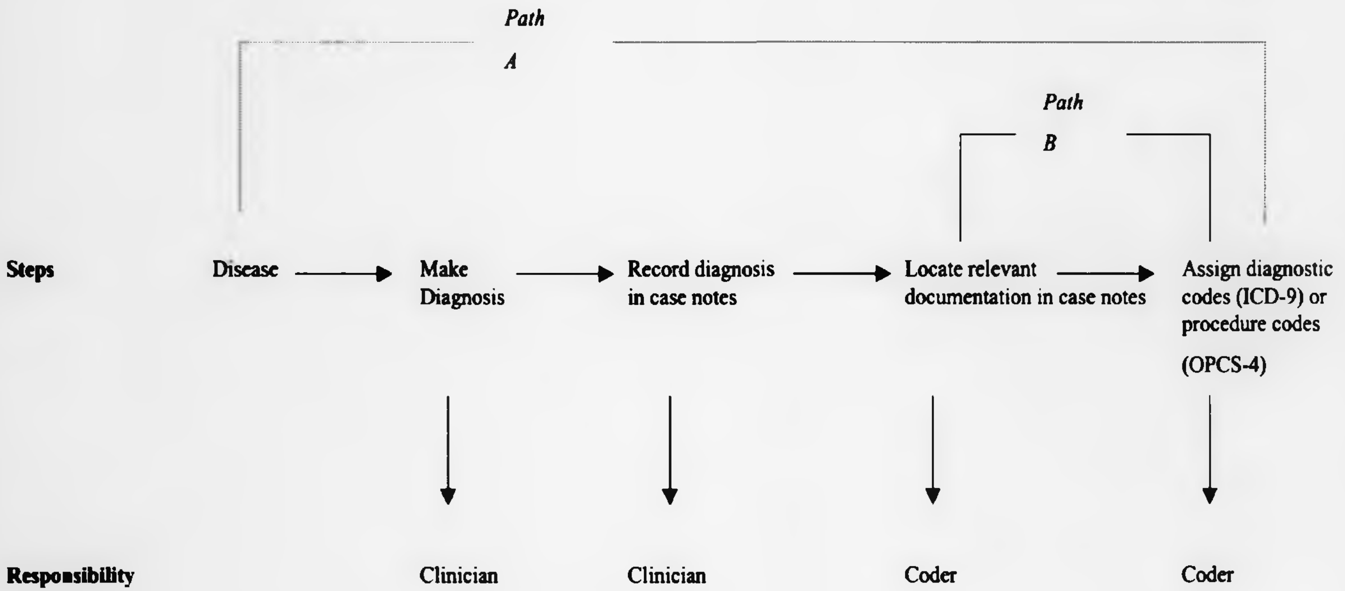
The results will not allay the widespread suspicions of the full clinical codes on the hospital episode statistics (HES) dataset. However, agreement about the first three characters in diagnostic and procedure codes was relatively good, particularly for certain conditions such as asthma. This, and the significant increase in agreement between years in Luton & Dunstable Hospital, is encouraging. The pattern of results was similar in both hospitals and reflects the results of earlier studies noted earlier.

Also table 22 indicates that for diagnoses, the differing codes chosen were for related conditions in a substantial proportion of cases. The disagreements in categories 5 and X are the most worrying. There may have been legitimate reasons for disagreement. For example the external coders, who coded 3-26 months after discharge, may have had access to information added to the notes after the local coding had been done, while the local coders may have had the benefit of querying the diagnoses 'on the spot' with clinicians.

The 'general' groups are nearest to being a presentation of the overall population of hospital discharges. Agreement in this group was lowest possibly because of rare, complex and ill-defined cases that were difficult to code. Exact agreement was higher for the more acute conditions selected - asthma, appendicitis and fractured femur. Diabetes seemed to present particular problems in the way the fourth digit of the ICD-9 code was used by different coders.

Not examined in the study was the extent to which the main diagnosis, as coded on hospital episode statistics data, really did represent the cause of admission. Also unexamined was the extent to which the main diagnosis was a code representing 'symptoms and signs' which may have been due to an ambulatory care sensitive or marker condition.

Figure 4 **A simple flow diagram showing the main steps involved in clinical coding from case notes, and the person responsible for each step**



What do the results imply about the quality of coding in the hospitals studied? Interpretation depends partly upon the quality of the external coders. All had coded for more than four years, and three had trained NHS regional and hospital coding managers in courses run by the Department of Health. In the past, CHKS coders have been found to be reliable (285), and in this study the proportion of disagreements over main diagnosis and procedure was consistent across all four coders. However they cannot be regarded as providing a gold standard. The very experienced regional 'third' coder agreed more often with the external than with the local teams, but often disagreed with both.

Also it is not possible with a study of this kind to assess the extent to which coding differences result from poor quality information in case notes or coding errors. The clinical information in the casenotes was frequently ambiguous, missing, illegible, or poorly organised (problems that have been noted elsewhere (290)). This was especially so in Lister Hospital, where there was more disagreement between all three groups of coders (table 24) and more disagreements in category X. While diagnosis is often complex and genuinely uncertain, it is the clinician's responsibility to document clearly codable conditions (291) and it is not for coders to try to work out what the diagnoses are. But even if clinical information is unambiguous, there may be intrinsic uncertainty in the process of clinical coding - in assigning and sequencing codes - and some level of disagreement between coders seems inevitable.

Could similar results be expected elsewhere? Neither hospital had unusual features, the pattern of results in each was broadly similar, and the results mirror those found in other studies noted above. As such the results presented here may well be generalisable, although there may well be greater variations between other acute hospitals in the region which were not included in this study. However some admissions excluded from the sample such as those in older people may be relatively difficult to code and so the results may underestimate the level of agreement across *all* admissions in acute hospitals. The case notes of approximately 9% of the sample could not be found, and they too could have been more difficult to code, although they were spread across all disease groups, specialties and ages and there was no evidence to suggest they were different to the admissions reviewed. Also only first episodes in the admissions were reviewed - secondary episodes may have been more difficult or easier to code. But since typically more than 90% of admissions on HES data contain just one episode, the effect of secondary episodes on the results is likely to have been very small.

5.5 Implications for the small area analysis described in this thesis

As noted above, this study did not investigate directly the *accuracy* but the *reproducibility* of clinical coding between two groups of coders. Furthermore, the reproducibility of coding was investigated in only two of the potential 16 main acute hospitals in NWT region whose data were to be used in the subsequent small area analysis.

The results were therefore only partially illuminating as to the accuracy of clinical coding of hospital episode statistics for the potential 23 admission groups, and the data in the other 14 main acute hospitals, to be used in the small area analysis. It was not possible, or appropriate, to use the findings from this study directly, for example in a sensitivity analysis in the small area analysis. The findings can at best provide a greater understanding as to the potential reasons for observed variations in admissions for specific conditions due to clinical coding.

Chapter 6 Small area analysis

<u>**Chapter outline**</u>

6.1 Introduction

This chapter describes the main analysis of the thesis - a small area analysis of admission rates for ACS and marker conditions. As outlined in chapters 1 and 2, there were three broad aims of the analysis:

- to investigate the relationship between admissions for ACS and marker conditions and socio-economic deprivation;
- to investigate the relationship between socio-economic deprivation and access to ambulatory care (in this case primary care);
- to investigate, in a multivariate analysis, the influence of several other factors – morbidity, access to hospital and general practice facilities and the 'hospital effect' – on admissions for ACS and marker conditions (as identified in chapter 3).

The geographical area under study was the former North West Thames NHS region - an area covering approximately 3.5 million people - and admissions data for 1991/2, 1992/3 and 1993/4 were used.

In this chapter the methods and main results are described and discussed.

6.2 Methods

6.2.1 Identifying small areas

Data identifying the geographical boundaries for the North West Thames region were obtained from the regional Information Department. Geographical boundaries for the enumeration districts (EDs) from the 1991 census were obtained from the Office for National Statistics. Approximately 70 EDs straddled the boundaries of the NHS region and other regions and were excluded from the analysis, leaving 8094 for analysis.

6.2.2 Building the dataset

To provide a basis for the analyses, a dataset was constructed containing admissions by enumeration district (ED) for various groups of diagnoses (the dependent variable) and eight main independent variables: standardised mortality ratio (SMR); standardised illness ratio (SIR); socio-economic deprivation (Carstairs index); age group; sex; access to hospital facilities; access to general practitioner services; and 'hospital service area'. The dataset was prepared by assigning a score to each ED for each variable as described below.

(a) The dependent variable

(i) Admissions per ED

As explained in chapter 4, routine hospital data in the UK NHS (hospital episode statistics or HES data) contain information on activity recorded as 'finished consultant episodes' (FCEs) rather than admissions. All FCEs for NWT residents during the study period (1991/2, 1992/3 and 1993/4) were obtained. FCEs occurring in providers within the NWT region were obtained from the regional Information Department (as described in chapter 4). FCEs occurring in providers outside the region were obtained from: North East Thames (NET) Regional Health Authority (covering admissions in providers in NET region); South West Thames (SWT) Regional Health Authority (admissions in SWT region); and Mersey Regional Health Authority (admissions in all other providers in England by NWT residents). These data were merged into one dataset. Data from private hospitals were not sought, partly because it was likely that the numbers of admissions for ACS and marker conditions would be very small (most admissions to private providers are for elective surgery (292), data would be difficult to obtain, and the quality of data (particularly postcode and diagnostic code) were unknown.

Duplicate episodes were removed (see chapter 4), as were FCEs for patients aged 75 and older, in well babies born in hospital and in the specialties of obstetrics, psychiatry, dental medicine, gynaecology and related specialties.

The remaining FCEs were grouped to represent admissions in individual patients. This was done for each acute provider listed in the HES dataset by matching the following data fields: patient identification number; age/date of birth; FCE start date; FCE end date; and FCE number. Across the whole dataset, the ratio of admissions to FCEs was 1:1.08.

In chapter 3, a total of 23 potential groups of conditions were identified for further analysis. It was thought that some of these should be included in the small area analysis because there might be important differences in the pattern of admission rates for strong and weak ACS conditions and markers, with different levels of urgency of admission. To reduce the admission groups to a more manageable number, groups 2, 4, 6, 8 and 22 were excluded. This was because ACS conditions may be recorded on HES as a main *or secondary* diagnosis, but as noted in chapter 5, the condition causing admission is most likely to be coded as a *main* diagnosis. A total of 18 admission groups remained for further analysis as summarised in the table below.

Table 25 Admission groups selected for further analysis, number of admissions in each group and percentage of all admissions, 1991/2

Admission group	Description	Admissions	% of all admissions
1	Strong and weak ACS conditions, any urgency, all	87669	25.92
3	Strong and weak ACS conditions, any urgency, readmissions	25278	7.47
5	Strong and weak ACS conditions, urgent, all admissions	31424	9.29
7	Strong and weak ACS conditions, urgent, readmissions	7719	2.28
9	Strong ACS conditions, any urgency, all admissions	30408	8.99
10	Strong ACS conditions, any urgency, readmissions	14738	4.36
11	Strong ACS conditions, urgent, all admissions	16341	4.83
12	Strong ACS conditions, urgent, readmissions	3685	1.09
13	Strong ACS conditions, very urgent, all admissions	20252	5.99
14	Strong ACS conditions, very urgent, readmissions	10286	3.04
15	Strong and weak markers, very urgent, all admissions	14577	4.31
16	Strong markers, very urgent, all admissions	13566	4.01
17	Admissions in surgical specialties	174736	51.66
18	Admissions in medical specialties	167161	48.42
19	Emergency admissions in surgical specialties	14690	4.34
20	Emergency admissions in medical specialties	33769	9.98
21*	Admissions for ACS conditions defined by Billings	3994	1.18
23*	Admissions for marker conditions defined by Billings	6176	1.83

* The list of ACS and marker conditions drawn up by Billings' et al comprised ICD-9CM (Clinically modified) codes. UK HES data contains ICD-9 codes, which lack the fifth digit found for some ICD-9 CM codes (which add precision to a diagnostic code) All ICD-9CM codes with the fifth digit were dropped from Billings' et al groupings – this affected only a small number of conditions.

As shown in the table, ACS admission group 1 comprised almost 26% of all admissions per study year, and admission group 16 (markers) approximately 4%.

Using the postcode recorded on the HES dataset, each admission was allocated to an enumeration district using a postcode-enumeration district 'look-up' table obtained from the Office for National Statistics.

(ii) calculating age-sex standardised admission rates

Age-sex standardised admission *rates* per ED were calculated for each of the 18 admission groups for the preliminary univariate and bivariate analyses.

Data on population size in the seven age bands by sex for all EDs in NWT region were obtained from the Office for National Statistics, using data from the 1991 census. The data were adjusted to allow for the estimated undercounting in some age groups using adjustment factors supplied by ONS (293). In the most extensive previous small area analysis in England (conducted by researchers at the University of York), the impact on the results of using direct standardisation rather than indirect were found to be negligible (99). The direct method was used here (by applying local rates to the England & Wales population in 1991). All the rates were expressed as admissions per 1000 population.

(iii) Poisson regression

To examine the influence of the independent variables on variations in admissions for the 18 admission groups, a multivariate Poisson regression analysis was performed. A Poisson regression rather than other forms of regression was conducted mainly because the numbers of events (admissions) in the EDs were small.

In this analysis, the *number* of admissions for each age and sex group was the dependent variable. This was related to the population number in each age and sex group for each ED and the independent variables described below.

(b) Independent variables

(i) Standardised mortality ratio (SMR) and standardised illness ratio (SIR)

Data on mortality (for persons under 75 years all causes) by ED for five years 1988-1992 (the most recent years available at the time of the study) were obtained from ONS. The SMR was calculated for each ED using indirect standardisation. Indirect standardisation was used because this method is typically used in small area studies for these variables (York), having lower variance in scores per ED compared to the direct method. Mortality data for five years, rather than one year, were used with the aim of reducing random variation in the SMR for ED populations.

The standardised illness ratio (SIR) was calculated using responses to the question on limited longstanding illness from the 1991 census (Scrivener 96). Age-sex standardised SIRs were calculated for each ED again using the indirect method.

(ii) Socio-economic deprivation

Data on socio-economic deprivation by ED were obtained from the ONS, derived from the 1991 census. A composite index of socio-economic deprivation - the Carstairs index - was calculated for each ED. The Carstairs index includes variables reflecting unemployment, proportion of households with no car, proportion of the population in a low socioeconomic class, and overcrowding (20). Carstairs scores generally range from –3 to +2, higher scores (ie the less negative) indicating higher levels of socioeconomic deprivation.

(iii) Age group, and sex

In the Poisson regression analysis, the numbers of people in each age and sex group per ED are treated as a particular kind of independent variable. In the dataset, a row of data is used for each age and sex group for each ED, with age and sex group indicated by single codes. For example using seven age groups (see below) and two sex groups, there were a total of 14 rows of data per ED showing the number of admissions by age and sex group.

Seven age groups were identified as follows:

Ages (years)	Age group
Under 1 year	1
1-4	2
5-14	3
15-24	4
25-44	5
45-64	6
65-74	7

Two sex groups were:

Sex	Group
Female	1
Male	2

(iv) Hospital service area

Hospital service areas (HSAs) (as defined in chapter 2) were identified for 17 main acute hospitals in the North West Thames region - those examined in chapter 4 but with Edgware and Barnet separated. As explained in chapter 4, in the analysis Charing Cross Hospital (Riverside NHS Trust) was excluded, although the number of EDs in this HSA is shown in the tables below.

(v) Hospital and GP access factors

A formula was used to calculate a score per ED that estimated the access of residents of the ED to GP and hospital facilities respectively. The formula was very similar to that developed by the University of York as part of a project to refine the allocation formula for NHS resources across England, as discussed in chapter 2 (99)

The formula used was:

$$HA(ED_i) = \sum_{h=1}^{3}\left[Beds_h /(d_{ih} + d_{offset})^2 / \sum_{i=1}^{n_h}\left(population_i /(d_{ih} + d_{offset})^2\right)\right]$$

Where:

$HA(ED_i)$	=	Hospital access factor for ED i
$\sum_{h=1}^{3}$	=	sum over the 3 hospitals h taking the most admissions from this ED
$Beds_h$	=	the number of acute beds in hospital h
d_{ih}	=	distance (km) from centroid of postcode of hospital h to centroid of ED i
d_{offset}	=	distance (= 5km) to be added to d_{ih} to avoid very high access near provider
$\sum_{i=1}^{n_h}$	=	sum over the n_h EDs in the service area of hospital h
$population_i$	=	population of ED_i

The model was based on the number of beds in hospitals serving the ED divided by the square of the distance from the ED to each hospital, taking into account the populations in other EDs who may 'compete' for those hospital beds. The square of the distance was used because this is typically used in calculations of this sort, and it was used in the formula developed by the University of York as referred to above. The offset' distance of 5km means that 5km was added to each distance to avoid implausibly high access factors when the distances involved were very small, for example in EDs very close to the hospitals. The figure of 5km was necessarily arbitrary – for example 10 or 20km could also have been used. However the shorter cut-off distance was used because of the density of the population and hospitals in London.

The resulting hospital access factor score (termed HAF2) was calculated for each ED. The higher the score, the higher the presumed access.

The GP access factor was calculated in a very similar fashion, except GP practices were used instead of hospitals, and the supply of full-time-equivalent (FTE) GPs instead of beds. The formula used was:

$$\text{GA}(\text{ED}_i) = \sum_{g=1}^{n_i}\left[FTE_g/(d_{ig}+d_{offset})^2 \Big/ \sum_{i=1}^{n_j}\left(population_i/(d_{ig}+d_{offset})^2\right)\right]$$

Where:

$\text{GA}(\text{ED}_i)$	=	GP access factor for ED i
$\sum_{g=1}^{n_i}$	=	sum over the n_i GP practices g in the ward containing ED_i
FTE_g	=	the number of FTE GPs in practice g
d_{ig}	=	distance (km) from centroid of postcode of practice g to centroid of ED_i
d_{offset}	=	distance (= 5km) to be added to d_{ig} to avoid very high access near provider
$\sum_{i=1}^{n_j}$	=	sum over the n_j EDs in the ward containing ED i.
$population_i$	=	population of ED_i

Again this formula is similar to that developed by the University of York in the work referenced above. However it was not clear from the University of York work which 'offset' distance was used. 5km was chosen here.

Also, because few studies have developed a formula in such a way to measure access to hospital or general practice or primary care, it was not clear whether to take the square of the distance, or some other power. We opted *a prioi* to use the square of the distance in the analysis (the scores were termed GAF2 or HAF2), but also did some exploratory analysis using GAF (distance unsquared), GAF4 (distance to the power of 4), GAF6 (power of 6) and HAF4 (power of 4).

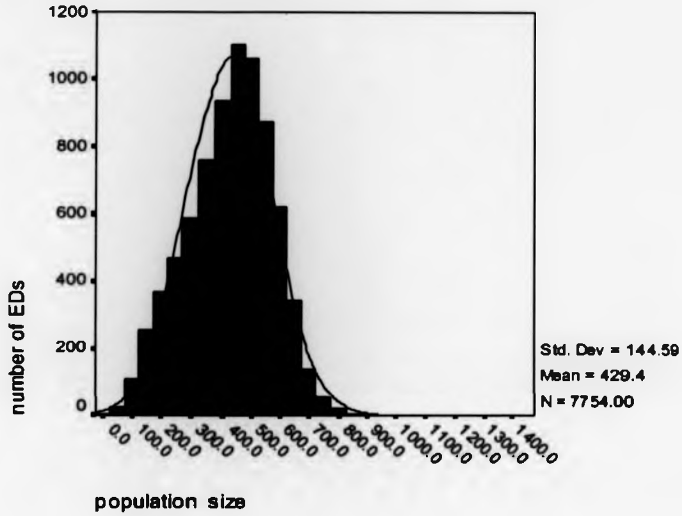
6.3 Results

6.3.1 Selection of data for analysis

(a) Number and population of EDs

A total of 8094 EDs were located wholly within the boundaries of the former NWT region in each of the study years. 340 EDs had no recorded population. The distribution of population in the remaining 7754 is shown below - the mean population size was 429.

Figure 5 **Distribution of EDs by population size**



(b) Assignment of EDs to hospital service areas

For each ED, the total number of admissions of NWT residents in each study year was identified, by hospital. All 7754 (populated) EDs in NWT region were then assigned to a particular hospital on the basis that the *largest proportion* of residents of the ED had occurred in that particular hospital (the 'plurality' rule) (262). The number of EDs assigned in this way to each of the 17 main acute hospitals in the former NWT region are shown below in the table below (column (a)).

Column (a) in table 26 (i) shows that of the total 7754 EDs with a population, in 6956 (89.7%) the largest proportion of admissions from the ED occurred in one of the 17 main acute hospitals within the region. In the remaining 794 EDs (approximately 10%) the largest proportion had occurred in a hospital outside of the region. This proportion was similar across the three study years.

As a next step, EDs with *less than 40%* of admissions occurring in the 17 main hospitals were identified (shown in column 'b') and excluded, as were EDs with a population too small (<100) to calculate a Carstairs score (Column 'c'). The number and proportion of EDs remaining made up each of the 17 hospital service areas (HSAs) as shown in columns 'e' and 'f'. On average less than 7% of EDs were excluded because of fewer than 40% of admissions occurring in the HSA (column 'f'). This was judged to be an acceptable proportion. However in several hospital service areas - Barnet, Ealing, Edgware, Central Middlesex – over 10% EDs were excluded using the 40% rule. These hospitals are located in a similar area – west and north west of London – and residents in local EDs may have tended to have been referred to inner London hospitals for admission.

The geographical location of EDs in each of the 17 HSAs in 1993/4 is shown in appendix A. The dots in the map show the geographical centroid of the ED rather than the boundaries, and dots of the same colour relate to the same HSA. The number and pattern of EDs within the HSAs remained fairly constant over the three study years because the flow of patients to the 17 study hospitals remained largely unchanged (data not shown).

Table 26 (i) The number of EDs in each hospital service area, 1991/2

		A	B	c	D b + c	e a - (b+c)	f ((a - (b+c))/a)*100
Acute Hospital	**Name of H.S.A**	**EDs assigned under plurality rule**	**EDs with <40% of admissions to this hospital**	**Remaining EDs with small population**	**Total EDs exluded**	**EDs included in H.S.A for further study**	**% of EDs in 'a' included in the H.S.A**
Ashford	**ASHF**	**256**	**8**	**3**	**11**	**245**	**95.7**
Barnet	BARN	**347**	55	3	**58**	**289**	83.3
Bedford	BEDF	425	9	3	12	413	97.2
Central Middlesex	CENT	344	60	1	61	283	82.3
Ealing	EALI	384	57	1	58	326	84.9
Edgware	EDGW	323	37	6	43	280	86.7
Hemel Hempstead	**HEME**	**438**	**9**	**7**	**16**	**422**	**96.3**
Hillingdon	**HILL**	**289**	**3**	**4**	**7**	**282**	**97.6**
Lister	**LIST**	**443**	**10**	**4**	**14**	**429**	**96.8**
Luton	**LUTO**	**589**	**4**	**3**	**7**	**582**	**98.8**
Mt Vernon	**MTVE**	**196**	**8**	**3**	**11**	**185**	**94.4**
Northwick Park	**NWIC**	**403**	**14**	**1**	**15**	**388**	**96.3**
Queen Elizabeth II	**QE2**	**326**	**6**	**2**	**8**	**318**	**97.5**
Charing Cross*	RIVE	877	31	15	46	831	94.8
St Mary's	STM2	717	23	12	35	682	95.1
Watford	WATF	336	5	1	6	330	98.2
West Middlesex	WMID	263	12	4	16	247	93.9
TOTAL		**6956**	**351**	**73**	**424**	**6532**	**93.9**

Bold type indicates the hospitals in which data were judged (in chapter 4) likely to be better quality.
Underlining indicates the hospitals for which better quality data were available in 1991/2, 1992/3 and 1993/4, ie for all three study years.
* Charing Cross (Riverside NHS Trust) was removed from all further analysis – see chapter 4.

Table 26 (ii) The number of EDs in each hospital service area, 1992/3

		a	B	c	d b + c	e a - (b+c)	f ((a - (b+c))/a)*100
Acute Hospital	**Name of H.S.A**	**EDs assigned under plurality rule**	**EDs with <40% of admissions to this hospital**	**Remaining EDs with small population**	**Total EDs exluded**	**EDs included in H.S.A for further study**	**% of EDs in 'a' included in the H.S.A**
Ashford	**ASHF**	**245**	**1**	**1**	**2**	**243**	**99.2**
Barnet	BARN	322	68	6	74	248	77.0
Bedford	**BEDF**	**422**	**5**	**3**	**8**	**414**	**98.1**
Central Middlesex	CENT	321	64	1	65	256	79.8
Ealing	**EALI**	**371**	**33**	**1**	**34**	**337**	**90.8**
Edgware	EDGW	314	38	4	42	272	86.6
Hemel Hempstead	HEME	445	19	6	25	420	94.4
Hillingdon	**HILL**	**278**	**4**	**2**	**6**	**272**	**97.8**
Lister	**LIST**	**465**	**6**	**2**	**8**	**457**	**98.3**
Luton	**LUTO**	**579**	**2**	**1**	**3**	**576**	**99.5**
Mt Vernon	MTVE	208	19	1	20	188	90.4
Northwick Park	**NWIC**	**408**	**8**	**2**	**10**	**398**	**97.5**
Queen Elizabeth II	**QE2**	**315**	**5**	**1**	**6**	**309**	**98.1**
Charing Cross*	RIVE	914	32	16	48	866	94.7
St Mary's	STM2	701	17	7	24	677	96.6
Watford	WATF	336	10	3	13	323	96.1
West Middlesex	WMID	251	9	4	13	238	94.8
TOTAL		6895	340	61	401	6494	94.2

Bold type indicates the hospitals in which data were judged (in chapter 4) likely to be better quality.
Underlining indicates the hospitals for which better quality data were available in 1991/2, 1992/3 and 1993/4, ie for all three study years.
* Charing Cross (Riverside NHS Trust) was removed from all further analysis – see chapter 4.

Table 26 (iii) The number of EDs in each hospital service area, 1993/4

		a	B	c	d b + c	e a - (b+c)	f ((a - (b+c))/a)*100
Acute hospital	Name of H.S.A	EDs assigned under plurality rule	EDs with <40% of admissions to this Hospital	Remaining EDs with small population	Total EDs exluded	EDs included in H.S.A for further study	% of EDs in 'a' included in the H.S.A
Ashford	**ASHF**	**254**	**3**	**1**	**4**	**250**	**98.4**
Barnet	**BARN**	**318**	**55**	**7**	**62**	**256**	**80.5**
Bedford	BEDF	437	9	3	12	425	97.3
Central Middlesex	CENT	326	56	1	57	269	82.5
Ealing	**EALI**	**351**	**36**	**1**	**37**	**314**	**89.5**
Edgware	**EDGW**	**301**	**28**	**1**	**29**	**272**	**90.4**
Hemel Hempstead	**HEME**	**457**	**15**	**4**	**19**	**438**	**95.8**
Hillingdon	**HILL**	**292**	**2**	**2**	**4**	**288**	**98.6**
Lister	**LIST**	**485**	**4**	**3**	**7**	**478**	**98.6**
Luton	LUTO	536	5	2	7	529	98.7
Mt Vernon	**MTVE**	**203**	**8**	**2**	**10**	**193**	**95.1**
Northwick Park	**NWIC**	**412**	**12**	**1**	**13**	**399**	**96.8**
Queen Elizabeth II	**QE2**	**343**	**10**	**2**	**12**	**331**	**96.5**
Charing Cross*	RIVE	847	40	9	49	798	94.2
St Mary's	**STM2**	**746**	**18**	**14**	**32**	**714**	**95.7**
Watford	**WATF**	**336**	**8**	**2**	**10**	**326**	**97.0**
West Middlesex	**WMID**	**254**	**4**	**2**	**6**	**248**	**97.6**
TOTAL		**6898**	**313**	**57**	**370**	**6528**	**94.6**

Bold type indicates the hospitals in which data were judged (in chapter 4) likely to be better quality.

Underlining indicates the hospitals for which better quality data were available in 1991/2, 1992/3 and 1993/4, ie for all three study years.

* Charing Cross (Riverside NHS Trust) was removed from all further analysis – see chapter 4.

(c) Selection of HSAs to be included in further analysis (after applying the 40% rule)

Table 26 (i), column 'e', shows that of the original dataset of 7754 EDs per study year, 6532 were included in 1991/2, 6494 in 1992/3 and 6528 in 1993/4. The number of EDs was reduced further for two reasons. First, EDs in HSAs of hospitals with data judged likely to be of poorer quality (see chapter 4 table 20) were removed, and the hospitals shown in bold type in table 26 are those for which data were judged likely to be of better quality. The number of EDs in these HSAs is shown in table 27 as **Group A** EDs. Group A EDs comprised 38.8% of the original total of 7754 in 1991/2, 37.1% in 1992/3 and 55.7% in 1993/4.

Second, further EDs were removed because there were difficulties in obtaining data to calculate the 'GP access factors' from two health authorities: Bedfordshire and Hounslow & Spelthorne. The lack of data on the number and location of GPs in these two health authorities meant that GP access factors could not be calculated in most EDs within these areas. This affected EDs in many HSAs but particularly those serving Bedford Hospital, Luton & Dunstable Hospital, Ashford Hospital and Lister Hospital, Stevenage. Because relatively few EDs remained in Luton and Ashford HSAs, these EDs were also removed and excluded from the multivariate analysis. The remaining EDs are shown in table 27 as **Group B** EDs. Group B EDs comprised 28.4% of the original total of 7754 in 1991/2, 21.8% in 1992/3 and 52.5% in 1993/4.

Finally, for the purpose of examining trends, from Group B EDs, only HSAs for which better quality data were available in all three study years were selected (those in table 26 indicated in bold type and underlined, excluding Luton and Ashford HSAs).The number of EDs in these four HSAs (Hillingdon, Lister, Northwick Park and Queen Elizabeth II) is shown in table 27 as **Group C** EDs. Group C EDs comprised 17.3% of the original total of 7754 in 1991/2, 17.4% in 1992/3 and 18.1% in 1993/4.

Table 27 Number of EDs in Group A, Group B and Group C by hospital service area (HSA), all years

	Number of EDs 1991/2				Number of EDs 1992/3				Number of EDs 1993/4			
Hospital service area (H.S.A)	**From Table 26**	**Group A**	**Group B**	**Group C**	**From Table 26**	**Group A**	**Group B**	**Group C**	**From Table 26**	**Group A**	**Group B**	**Group C**
Ashford	245	245	*[74]*		243	243	*[71]*		250	250	*[75]*	
Barnet	289	289	280		248				256	256	254	
Bedford	413				414	414	*[0]*		425			
Central Middlesex	283				256				269			
Ealing	326				337	337	336		314	314	312	
Edgware	280				272				272	272	272	
Hemel Hempstead	422	422	398		420				438	438	419	
Hillingdon	282	282	282	282	272	272	272	272	288	288	287	287
Lister	429	429	363	363	457	457	380	380	478	478	390	390
Luton & Dunstable	582	582	*[39]*		576	576	*[34]*		529			
Mount Vernon	185	185	182		188				193	193	190	
Northwick Park	388	388	387	387	398	398	397	397	399	399	399	399
Queen Elizabeth II	318	318	316	316	309	309	307	307	331	331	329	329
Charing Cross*	831				866				798			
St Mary's	682				677				714	714	684	
Watford	330				323				326	326	294	
West Middlesex	247				236				248	248	248	
TOTAL	**6532**	**3140**	**2208**	**1348**	**4390**	**3006**	**1692**	**1356**	**6528**	**4507**	**4078**	**1405**
% of all EDs in NWT	**80.7**	**38.8**	**28.4**	**17.3**	**54.2**	**37.1**	**21.8**	**17.4**	**80.7**	**55.7**	**52.5**	**18.1**

Key: **Group A EDs** : EDs in HSAs in which admissions data were thought to be adequate (from chapter 4)
Group B EDs: A subset of Group A EDs for which it was possible to calculate access factor scores
Group C EDs: A subset of Group B EDs for which data were judged to be adequate across all three study years
* Charing Cross (Riverside NHS Trust) was removed from all further analysis – see chapter 4.

In summary **Group A** EDs were those in HSAs in which the quality of admissions data were judged to be adequate (in chapter 4). **Group B** EDs were a subset of Group A for which it was possible to calculate access factor scores. **Group C** EDs were a subset of Group B for which admissions data were judged adequate for all three study years, allowing an analysis across time.

In different analyses below, different groups of EDs are used. Group A EDs are generally used to describe the frequency distributions of variables and for some bivariate analyses. Group B and C EDs are used for bivariate analyses using access factors and for the multivariate analysis.

6.3.2 Univariate analyses and comparisons by HSA

(a) Age-sex standardised admission rates across EDs

Using Group A EDs, the distribution of the age-sex standardised rates for all 18 admission groups is shown in table 28. Only data for one year, 1993/4 are shown.

The data show that, for the ACS admission groups (1-14), the mean rates were highest in group 1, at 31.09 per 1000 admissions, and high in groups 5 and 9. Rates were much lower in marker admission groups (15 and 16) at between 4-5 per 1000. Rates in Billings' ACS (group 21) and marker (group 23) groups were very low at 1-2 per 1000.

The rate in group 19 (emergency surgical) was roughly 8% of that in group 17 (all surgical admissions), whereas the rate in group 20 (emergency medical admissions) was 18% of that in group 18 (all medical admissions). The proportion of readmissions tended to be higher in admission groups representing strong ACS conditions. The pattern seen in the table mirrors that shown in table 25, although in table 25 data on all EDs were used, while in table 28 data from a subset of those in table 25 were used.

To understand better the change in rates over time, the rates in all Group C EDs across the region were calculated, for group 1 and group 16 only (for simplicity). The results are shown in table 29.

Table 28 Age-sex standardised admission rates by admission group, 1993/4

Admission Group	Description	Rate per 1000			
		Mean	Median	Standard deviation	n
1	Strong and weak ACS conditions, any urgency, all	31.10	28.67	16.89	4450
3	Strong and weak ACS conditions, any urgency, readmissions	7.43	5.41	7.92	4450
5	Strong and weak ACS conditions, urgent, all admissions	11.57	9.82	9.31	4450
7	Strong and weak ACS conditions, urgent, readmissions	3.12	1.63	4.84	4450
9	Strong ACS conditions, any urgency, all admissions	11.52	9.72	9.24	4450
10	Strong ACS conditions, any urgency, readmissions	7.11	4.06	10.10	4450
11	Strong ACS conditions, urgent, all admissions	5.92	4.50	6.24	4450
12	Strong ACS conditions, urgent, readmissions	1.37	0.00	3.13	4450
13	Strong ACS conditions, very urgent, all admissions	7.13	5.61	6.65	4450
14	Strong ACS conditions, very urgent, readmissions	3.58	2.20	4.71	4450
15	Strong and weak markers, very urgent, all admissions	4.94	4.02	4.69	4450
16	Strong markers, very urgent, all admissions	4.57	3.67	4.49	4450
17	Admissions in surgical specialties	61.75	58.69	26.44	4450
18	Admissions in medical specialties	73.02	55.42	82.77	4450
19	Emergency admissions in surgical specialties	5.31	4.11	5.53	4450
20	Emergency admissions in medical specialties	13.77	11.25	12.64	4450
21	Admissions for ACS conditions defined by Billings	1.56	0.00	2.54	4450
23	Admissions for marker conditions defined by Billings	2.06	1.44	2.73	4450

Group A EDs

Table 29 Comparisons of age-sex standardised admission rates across 3 study years, for admission groups 1 and 16.

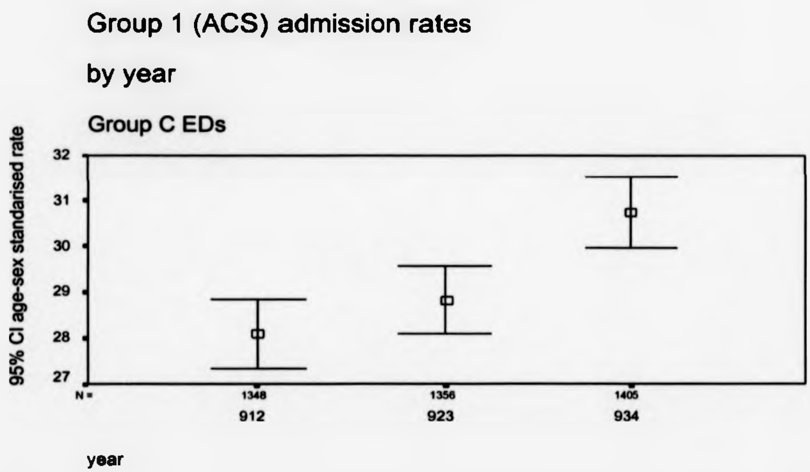
		1991/2			1992/3			1993/4		
Admission group	Brief description	Mean	Standard deviation	n	Mean	Standard deviation	n	Mean	Standard deviation	n
1	Strong and weak ACS conditions, any urgency, all	28.09	14.04	1348	28.82	13.86	1356	30.74	15.09	1405
16	Strong markers, very urgent, all admissions	4.61	4.28	1348	4.64	4.28	1356	4.72	4.38	1405

Group C EDs

The results show that there was an increase in the mean rates in 1993/4 in group 1 ACS admissions - from 28.09 in 1991/2 to 30.74 in 1993/4. The rates for marker conditions were stable across the three years.

These results for admission group 1 (ACS conditions) were plotted on an error bar graph, showing the mean and 95% confidence intervals of the values (figure 6 – note truncated axis).

Figure 6



The figure shows that the increase between 1993/4 and the earlier years was statistically significant ($p < 0.05$).

The standardised admission rates were then examined by HSA, as shown in the next table. For simplicity, again the results for only two admission groups are shown ((group 1 (ACS) and group 16 (markers)) for 1993/4.

Table 30 **Age-sex standardised admission rates by HSA, 1993/4 (ranked by descending order of the mean)**

	Admission group 1 (ACS)		
Hospital service Area	**Mean**	**Standard Deviation**	**n=**
West Middlesex	34.79	16.85	248
Ealing	34.59	15.98	313
Northwick Park	33.72	15.71	399
Watford	33.35	15.81	318
St Mary's Paddington	33.26	23.86	687
Hillingdon	33.03	13.88	285
Edgware	31.98	17.85	272
Mt Vernon	30.26	13.55	193
Barnet	30.10	15.39	256
Hemel Hempstead	28.12	14.21	421
Lister	28.01	13.73	477
Queen Elizabeth II	27.11	13.33	331
Ashford	24.60	12.8	250
TOTAL	**31.09**	**16.89**	**4450**

Group A EDs

	Admission group 16 (marker)		
Hospital service Area	**Mean**	**Standard Deviation**	**n=**
Lister	5.39	4.88	477
Ealing	5.08	4.67	313
West Middlesex	5.04	4.62	248
Barnet	4.93	4.75	256
Watford	4.88	4.14	318
Queen Elizabeth II	4.82	4.50	331
Edgware	4.76	4.03	272
Hemel Hempstead	4.48	4.08	421
Hillingdon	4.39	4.00	285
Mt Vernon	4.25	3.59	193
Northwick Park	4.00	3.36	399
St Mary's Paddington	3.92	5.54	687
Ashford	3.85	3.51	250
TOTAL	**4.57**	**4.48**	**4450**

Group A Eds

The results show that there were marked differences between HSAs for admission group 1, for example the mean rate in West Middlesex was 34.79 compared to Ashford at 24.6 per 1000. The differences were smaller, although proportionately as great, between HSAs for group 16 (marker) admissions.

Table 31 below shows that the rates increased in three of the four HSAs in 1993/4, with the rise being most noticeable in Northwick Park.

Table 31 Age-sex standardised admission rates (per 1000) for admission group 1, by year

Hospital service area	1991/2		
	Mean	Standard Deviation	n
Hillingdon	32.07	16.04	282
Lister	26.89	13.73	363
Northwick Park	28.37	12.87	387
Queen Elizabeth II	25.61	13.11	316
Total	28.09	14.04	1348

Hospital service area	1992/3		
	Mean	Standard Deviation	N
Hillingdon	33.93	14.37	272
Lister	26.87	13.39	380
Northwick Park	29.31	13.26	397
Queen Elizabeth II	26.07	13.52	307
Total	28.82	13.86	1356

Hospital service area	1993/4		
	Mean	Standard Deviation	N
Hillingdon	33.04	13.85	287
Lister	29.07	15.86	390
Northwick Park	33.72	15.71	399
Queen Elizabeth II	27.11	13.33	329
Total	30.74	15.09	1405

Group C EDs

(b) Carstairs score

Using Group A EDs, the mean and standard deviation of scores per HSA per year were calculated. Data from 1993/4 are presented (table 32), but since data from two HSAs (Luton and Bedford) were not adequate in this year (see table 26), data for 1992/3 were used.

Table 32 Descriptive statistics for Carstairs, SMR and SIR scores, by HSA 1993/4 (ranked by Carstairs score)

Hospital service area (HSA)	Carstairs score 1993/4		SMR 1993/4		SIR 1993/4		
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	n
Mt Vernon	-2.62	1.33	0.95	0.40	0.87	0.23	193
Hemel Hempstead	-2.21	1.55	0.98	0.40	0.89	0.24	438
Queen Elizabeth II	-1.98	1.50	1.01	0.50	0.84	0.24	331
Barnet	-1.79	1.65	1.03	0.44	0.91	0.21	256
Watford	-1.74	2.08	1.06	0.88	0.86	0.24	326
Ashford	-1.64	1.68	1.02	0.44	0.88	0.22	250
Bedford*	-1.41	2.47	1.03	0.45	0.91	0.25	414
Lister	-1.41	1.75	1.01	0.52	0.85	0.23	478
Northwick Park	-1.19	1.86	0.93	0.40	0.88	0.21	399
Edgware	-0.63	2.29	0.92	0.42	0.89	0.27	272
Hillingdon	-0.53	1.76	1.02	0.45	0.86	0.22	288
Luton*	-0.23	3.07	1.01	0.44	0.86	0.24	576
West Middlesex	0.42	1.88	0.98	0.44	0.86	0.22	248
Ealing	1.29	3.04	1.00	0.54	0.90	0.24	314
St Mary's Paddington	1.94	2.83	0.98	0.71	0.76	0.28	714

Group A EDS

* Data refer to 1992/3

The table shows that the HSAs with higher mean Carstairs scores (ie greater deprivation) were St Mary's, Ealing, West Middlesex , Luton and Hillingdon. The HSAs with the lowest scores were: Mt Vernon, Hemel Hempstead and QE2. Across most of the region, the mean scores were mostly negative, indicating lower levels of socio-economic deprivation than the rest of England & Wales.

(c) Standardised mortality ratio (SMR) and standardised illness ratio (SIR)

Table 32 also shows information on the SMR and SIR scores by HSA. The table shows that the mean SMR in most HSAs was close to 1, indicating SMRs similar to that in England & Wales. Lower mean values (ie lower rates compared to England & Wales) were found in Northwick Park (0.93) and Edgware (0.92).

For the SIR, all the mean scores were below 1, indicating lower rates of people reporting limiting longstanding illness than in England & Wales as a whole. St Mary's HSA contained EDs with the lowest mean score, which was surprising considering that it is located in a deprived inner city area (Paddington). Undercounting in the 1991 census, which affected deprived inner city areas the most (294) might have excluded residents who were most likely to report illness, although most of the undercounted were estimated to be young males who are generally a healthy group.

(d) GP and hospital access factors

Table 33 below shows descriptive statistics for the two access factors, by hospital service area for 1993/4.

Table 33 **Descriptive statistics for GP (GAF2) and hospital access factors (HAF2), by hospital service area, 1993/4 (ranked in order of the mean)**

Hospital service area (HSA)	GP Access Factor (GAF2)		
	Mean	Standard Deviation	n
St Mary's Paddington	0.546	0.517	684
Ealing	0.382	0.446	312
Edgware	0.329	0.467	272
Northwick Park	0.270	0.364	399
West Middlesex	0.242	0.384	248
Barnet	0.179	0.355	254
Hillingdon	0.161	0.241	287
Mt Vernon	0.133	0.205	190
Watford	0.122	0.208	294
Queen Elizabeth II	0.075	0.240	329
Hemel Hempstead	0.074	0.153	419
Lister	0.052	0.196	390

Table 33 Continued

Hospital service area (HSA)	Hospital Access Factor (HAF2) Mean	Standard Deviation	N
Lister	0.086	0.074	390
Hillingdon	0.060	0.048	287
St Mary's Paddington	0.032	0.148	684
West Middlesex	0.021	0.107	248
Watford	0.014	0.071	294
Edgware	0.014	0.059	272
Mt Vernon	0.013	0.079	190
Barnet	0.009	0.058	254
Hemel Hempstead	0.007	0.038	419
Queen Elizabeth II	0.004	0.020	328
Ealing	0.004	0.026	312
Northwick Park	0.003	0.019	399

Group B EDs

In the table, higher GP access factor (GAF2) scores are apparent in HSAs closer to central London, such as St Mary's (STM2), Ealing (EALI) and Edgware (EDGW), and lower in relatively rural areas (such as Lister (LIST) Hemel Hempstead (HEME) and Queen Elizabeth II (QE2). Similar results were found in 1991/2 and 1992/3 (data not shown). For the hospital access factor (HAF2), the mean values were not obviously higher in HSAs closer to central London with the exception of St Mary's Paddington.

To examine the access factors further, the frequency distribution of the scores for GAF2 and HAF2 were plotted by HSA. Logged scores (using natural logarithms) were used to try to reduce the skewness of the distribution. The results are shown in appendix B. For simplicity data for one year, 1993/4 are shown – the results for the previous two years were similar. Appendix B shows that the scores for the logged GAF2 score (LGAF2) approximated roughly to a normal distribution, with skewing to the left in some HSAs. There was a more marked skew to the left for the logged HAF2 scores (LHAF2).

6.3.3 Bivariate analysis

(a) Correlation between the main independent variables

Because of skewness in the distribution of the access factor scores, this bivariate analysis was carried out using quintile scores rather than the raw values. The Pearson product moment correlation coefficients are shown in the table below. For simplicity one variable is used to represent each of the access factors.

There was a non-significant (p> 0.05) association between the Carstairs quintile and the SMR quintile, and a significant (p> =0.005) but weak *negative* association between the SIR quintile and the Carstairs quintile. The relationship between the SMR and SIR with the access quintiles was mostly not significant, although there was a positive and significant (p>0.0001) relationship between Carstairs and both access scores. As to be expected there was a positive and significant (p < 0.0001) relationship between the access quintiles.

Table 34 Correlations between the main independent variables

Variables	Carsquin	Smrquin	Sirquin	Gaf2quin	Haf2quin
Carsquin	1.0000				
Smrquin	-0.0242	1.0000			
P =	0.1225				
Sirquin	-0.0439	0.1740	1.0000		
P=	0.0050	0.0000			
Gaf2quin	0.4383	-0.0338	-0.0264	1.0000	
P=	0.0000	0.0308	0.0918		
Haf2quin	0.2908	-0.0190	-0.0385	0.3811	1.0000
P=	0.0000	0.2254	0.0139	0.0000	

Group B EDs

P= statistical significance

(b) Correlation between standardised admission rates and socio-economic deprivation

One of the main hypotheses in this thesis was that there would be a significant positive correlation between socio-economic deprivation with admissions for ACS conditions, and no significant correlation for marker conditions.

The analysis involved Group A EDs. Bivariate analyses were performed using age-sex standardised admission rates by ED (for all admission groups) and Carstairs scores (raw values). The Pearson product moment correlation was used to assess the closeness of the association between the two continuous variables. The results across the region for 1993/4 are shown in the table below.

Table 35 Correlation between Carstairs score and admission rates by admission group, 1993/4

Admission Group	Description	Pearson correlation with Carstairs	Significance (2-tailed)
1	Strong and weak ACS conditions, any urgency, all	0.325	0.01
3	Strong and weak ACS conditions, any urgency, readmissions	0.225	0.01
5	Strong and weak ACS conditions, urgent, all admissions	0.265	0.01
7	Strong and weak ACS conditions, urgent, readmissions	0.172	0.01
9	Strong ACS conditions, any urgency, all admissions	0.304	0.01
10	Strong ACS conditions, any urgency, readmissions	0.168	0.01
11	Strong ACS conditions, urgent, all admissions	0.209	0.01
12	Strong ACS conditions, urgent, readmissions	0.117	0.01
13	Strong ACS conditions, very urgent, all admissions	0.152	0.01
14	Strong ACS conditions, very urgent, readmissions	0.186	0.01
15	Strong and weak markers, very urgent, all admissions	0.125	0.01
16	Strong markers, very urgent, all admissions	0.121	0.01
17	Admissions in surgical specialties	0.276	0.01
18	Admissions in medical specialties	0.206	0.01
19	Emergency admissions in surgical specialties	0.018	not significant
20	Emergency admissions in medical specialties	0.065	0.01
21	Admissions for ACS conditions defined by Billings	0.104	0.01
23	Admissions for marker conditions defined by Billings	0.034	0.05

Group A EDs

Table 35 shows that there was a significant positive correlation between admission rates for most groups and the Carstairs score. The correlations were higher in the ACS admission groups 1, 2, 3, 9 and 11 (ie the admission groups using *all admissions* rather than *readmissions*) and lower in marker groups. The lower correlations in the readmissions groups may be because of the lower number of events. Correlations were higher in the all surgical and all medical admissions group compared to the emergency surgical and emergency medical admissions groups. Correlations were low with Billings' ACS and marker groups. The results were similar in the study years 1991/2 and 1992/3. The results are presented in such a way as to allow some comparison between groups, but it is important to note that interpretation is not straightforward because the numbers of admissions in each group is different, and some groups (eg group 3) are subsets of others (eg group 1).

As a further analysis to compare rates in deprived and non-deprived areas, the ratio of mean rates in the most deprived quintile of EDS (using Group A) and in the least deprived quintile of EDs were calculated for all 18 admission groups and for all three study years. The table in appendix C shows the results.

In each year the ratios varied mainly between 1.5 and 2.5; ratios for ACS conditions were generally nearer 2, and ratios for markers were nearer 1.5. Interestingly the ratios were generally higher in ACS groups in 1993/4 compared to other years, and for the ACS groups representing readmissions (in contrast to the results shown in table 35), suggesting that socioeconomic deprivation is associated with a higher rate of readmissions for ACS conditions particularly in 1993/4. The ratio was lowest for emergency surgical admissions (group 19), conditions for which the decision to admit is unlikely to be discretionary.

6.3.4 Multivariate analysis using Poisson regression

(a) Developing the model

The regression model used for the analysis was:

ADMISSIONS (group) = *f (POPN, AGE-GRP, SEX, SMR, SIR, CARST, HAF2, GAF2, HSA)*

Where:

ADMISSIONS (group)	=	number of admissions per ED in a particular admission group by age and sex group
POPN	=	total population count per ED, by age and sex group
AGE-GRP	=	age group (7 age bands were chosen - see above)
SEX	=	sex (male, female - see above)
SMR	=	standardised mortality ratio per ED (all causes aged under 75 years, 1988-92)
SIR	=	standardised illness ratio per ED
CARST	=	Carstairs' score per ED
GAF2 (GAF, GAF4)	=	GP access factor scores per ED
HAF2	=	hospital access factor scores per ED
HSA	=	hospital service area

The first step was try to simplify the dataset by calculating some derived variables. Using **Group B** EDs, the scores per ED for each of the five main variables (SMR, SIR, CARST, GAF2 and HAF2) were grouped into quintiles (eg SMRQUIN1 to SMRQUIN5). Using the exact scores would assume a linear relationship in the regression between these variables and the dependent variable, whereas grouping the scores by quintiles would allow for a non-linear (eg curvilinear) relationship, and would reduce problems in analysis with the skewed distribution of access factors. Using the quintiles in this way, the regression model (consisting of the variables shown above) was termed the 'full' model.

The results of the Poisson regression analysis are shown in appendix D. In the appendix, the 'IRR' shown represents the *incremental relative risk ratio*. The IRR is a value that represents the effect of the value of the variable in question, relative to a baseline value. For example, in the table, the value of CARSQ2 is 1.22 relative to the baseline variable CARSQ1 at 1.000. This means that, taking other variables into account, the mean number of admissions for EDs in the second quintile of the Carstairs score (CARSQ2) is 22% higher than that of the first quintile (CARSQ1).

The table in appendix D shows that, using the quintile scores in the full model (using group 1 ACS conditions in 1991/2 as the dependent variable and including GAF2 and HAF2 as access factors) the relationships with SMR, SIR and CARST were approximately linear. In other words, the IRRs for the quintiles increased successively from the first to the fifth quintile (eg from CARSQ1 to CARSQ5). These results were typical for other admission groups and other years. Therefore, for simplification, the quintile scores for each variable SMR, SIR and CARST were thus used as a single numerical variable (eg SMRQUIN, SIRQUIN) rather than using indicator variables (eg SMRq1, SMRq2 etc) as shown in appendix D for each quintile group.

However, as appendix D shows, it was not clear whether there was a linear relationship between admissions and HAF2 and GAF2 respectively. The IRRs did not suggest a clear linear pattern, the confidence intervals of the IRRs were wide, and the picture across the different ACS groups (data not shown) was mixed. Therefore to simplify the model, four of the quintiles for GAF2 and HAF2 were grouped in pairs (eg GAF2q1, GAF2q23, GAF2q45), rather than used as a single numerical variable (eg GAF2QUIN).

Using the single 'collapsed' variables – SMRQUIN, SIRQUIN, CARSQUIN – and the grouped quintiles for GAF2 and HAF2, the regression model was termed the 'simplified' model.

To test the effect on the fit using the simplified model, rather than the full model, Poisson regressions were run on both models and the 'pseudo' r-squared coefficients were compared. Pseudo r-squared statistics "*provide a quick way to describe or compare the fit of different models for the same dependent variable*"(295), although they "*lack the straightforward explained-variance interpretation of the true r-squared coefficient as found in ordinary least squares regression*". The values of pseudo r-squared statistics are always found in the range 0 to 1, 1 representing a perfect fit and 0 representing no fit. The results are shown appendix E. The IRR values were only slightly lower for the simplified model indicating little loss of explanatory power. As a result, the simplified model was used in all further analyses.

The pseudo r-squared scores in appendix E show that between approximately 10-20% of variation in admissions for ACS conditions between EDs was 'explained' by either model, and around 5% of variation for marker conditions. The greatest explanatory power (22-24%) occurred for admission group 20 (emergency medical admissions) in contrast with group 19 (emergency surgical admissions) at 9-13%. The pseudo r-squared scores for the simplified model using Group C EDs (data not shown) were very similar to those shown using Group B EDs.

(b) Running the Poisson regression model

The simplified model was first run using Group B EDs for each study year, and then Group C EDs (1991/2, 1992/3, 1993/4 and all years combined) to allow a comparison across all three study years. For simplicity, the results are presented here only for Group B EDs in 1993/4 (those using Group B EDs in earlier years were similar). Results for Group C EDs 1991-4 are shown in appendix F. The results are shown first for variables representing mortality (SMR), morbidity (SIR), and socio-economic deprivation (CARS), then for different age-groups, then for variables representing access to general practice and hospital facilities (GAF2 and HAF2). Results for the HSA variables are shown last.

(i) SMR, SIR, and Carstairs index

The next table shows the results across all 18 admission groups for 1993/4.

The results show that there was a positive association between admissions and the three variables for all admission groups. For example, for group 1 the admission rate increases by an average of 11.6% for each quintile of Carstairs score. In most cases the association was significant. The positive relationship was very similar for SIR and SMR, and stronger for CARS, especially in admission groups 10, 7, 3, 12 and 14 (all representing readmissions).

Table 36 Incremental relative risk ratios for selected variables: Carstairs quintile; SMR quintile; and SIR quintile, 1993/4

		Carstairs				SMR				SIR			
Admission Group	Description	IRR	P Value	95% ci lower	upper	IRR	p value	95% ci lower	upper	IRR	p value	95% ci lower	upper
1	Strong and weak ACS conditions, any urgency, all	1.1160	0.000	1.1087	1.1233	1.0446	0.000	1.0381	1.0511	1.0510	0.000	1.0445	1.0575
3	Strong and weak ACS conditions, any urgency, readmissions	1.1712	0.000	1.1554	1.1872	1.0551	0.000	1.0417	1.0686	1.0934	0.000	1.0796	1.1074
5	Strong and weak ACS conditions, urgent, all admissions	1.1367	0.000	1.1249	1.1486	1.0339	0.000	1.0239	1.0440	1.0591	0.000	1.0488	1.0694
7	Strong and weak ACS conditions, urgent, readmissions	1.1833	0.000	1.1595	1.2075	1.0235	0.015	1.0044	1.0430	1.1030	0.000	1.0823	1.1241
9	Strong ACS conditions, any urgency, all admissions	1.1047	0.000	1.0929	1.1167	1.0314	0.000	1.0210	1.0419	1.0497	0.000	1.0391	1.0603
10	Strong ACS conditions, any urgency, readmissions	1.1909	0.000	1.1733	1.2088	1.0490	0.000	1.0345	1.0637	1.0814	0.000	1.0665	1.0964
11	Strong ACS conditions, urgent, all admissions	1.1101	0.000	1.0942	1.1261	1.0215	0.002	1.0079	1.0352	1.0605	0.000	1.0463	1.0748
12	Strong ACS conditions, urgent, readmissions	1.1760	0.000	1.1408	1.2123	1.0053	0.710	0.9775	1.0339	1.0987	0.000	1.0681	1.1302
13	Strong ACS conditions, very urgent, all admissions	1.1144	0.000	1.0941	1.1351	1.0083	0.342	0.9912	1.0256	1.0576	0.000	1.0396	1.0759
14	Strong ACS conditions, very urgent, readmissions	1.1334	0.000	1.1187	1.1483	1.0273	0.000	1.0149	1.0399	1.0504	0.000	1.0377	1.0633
15	Strong and weak markers, very urgent, all admissions	1.1053	0.000	1.0879	1.1230	1.0595	0.000	1.0438	1.0754	1.0404	0.000	1.0251	1.0560
16	Strong markers, very urgent, all admissions	1.1036	0.000	1.0855	1.1219	1.0568	0.000	1.0405	1.0733	1.0351	0.000	1.0192	1.0512
17	Admissions in surgical specialties	1.0843	0.000	1.0794	1.0892	1.0518	0.000	1.0473	1.0563	1.0301	0.000	1.0257	1.0345
18	Admissions in medical specialties	1.0725	0.000	1.0676	1.0774	1.0489	0.000	1.0444	1.0535	1.0574	0.000	1.0529	1.0620
19	Emergency admissions in surgical specialties	1.0864	0.000	1.0713	1.1017	1.0604	0.000	1.0466	1.0744	1.0207	0.002	1.0074	1.0341
20	Emergency admissions in medical specialties	1.0960	0.000	1.0855	1.1066	1.0488	0.000	1.0394	1.0584	1.0548	0.000	1.0453	1.0644
21	Admissions for ACS conditions defined by Billings	1.1838	0.000	1.1505	1.2180	1.0237	0.086	0.9966	1.0515	1.0826	0.000	1.0541	1.1190
23	Admissions for marker conditions defined by Billings	1.0682	0.000	1.0440	1.0930	1.0592	0.000	1.0364	1.0825	1.0382	0.001	1.0160	1.0608

Group B EDs

(ii) Age-groups

Table 37 below shows the pattern of results across the seven different age groups for all 18 admission groups again for Group B EDs in 1993/4. The results are shown for age groups 2-7 relative to the baseline age group 1.

Table 37 Incremental risk ratios for 'age group', by admission group, data for all years combined

Admission Group	Description	Age Group	IRR	p value	95% c.i lower	upper
1	Strong and weak ACS conditions, any urgency,	1	1.00	-	-	-
	All admissions	2	0.59	0.000	0.56	0.62
		3	0.24	0.000	0.23	0.25
		4	0.12	0.000	0.12	0.13
		5	0.20	0.000	0.19	0.21
		6	0.46	0.000	0.44	0.48
		7	0.83	0.000	0.80	0.87
3	Strong and weak ACS conditions, any urgency,	1	1.00	-	-	-
	Readmissions	2	0.39	0.000	0.37	0.44
		3	0.12	0.000	0.10	0.13
		4	0.06	0.000	0.05	0.06
		5	0.10	0.000	0.10	0.11
		6	0.37	0.000	0.34	0.40
		7	0.84	0.000	0.77	9.09
5	Strong and weak ACS conditions,urgent,	1	1.00	-	-	-
	All admissions	2	0.59	0.000	0.56	0.63
		3	0.18	0.000	0.17	0.19
		4	0.08	0.000	0.08	0.09
		5	0.06	0.000	0.06	0.07
		6	0.17	0.000	0.16	0.18
		7	0.45	0.000	0.42	0.47
7	Strong and weak ACS conditions, urgent,	1	1.00	-	-	-
	Readmissions	2	0.42	0.000	0.38	0.49
		3	0.11	0.000	0.09	0.12
		4	0.03	0.000	0.03	0.04
		5	0.04	0.000	0.03	0.04
		6	0.16	0.000	0.15	0.18
		7	0.46	0.000	0.43	0.51
9	Strong ACS conditions, any urgency,	1	1.00	-	-	-
	All admissions	2	0.68	0.000	0.63	0.74
		3	0.34	0.000	0.31	0.37
		4	0.20	0.000	0.18	0.22
		5	0.24	0.000	0.22	0.26
		6	0.42	0.000	0.39	0.45
		7	0.60	0.000	0.56	0.65
10	Strong ACS conditions, any urgency,	1	1.00	-	-	-
	Readmissions	2	0.50	0.000	0.45	0.57
		3	0.19	0.000	0.17	0.21
		4	0.09	0.000	0.08	0.10
		5	0.14	0.000	0.13	0.16
		6	0.71	0.000	0.64	0.86
		7	1.68	0.000	1.52	1.86
11	Strong ACS conditions, urgent,	1	1.00	-	-	-
	All admissions	2	0.75	0.000	0.69	0.82
		3	0.34	0.000	0.31	0.37
		4	0.14	0.000	0.12	0.15
		5	0.11	0.000	0.10	0.12
		6	0.17	0.000	0.16	0.19
		7	0.32	0.000	0.27	0.33

Table 37 Continued

Admission Group	Description	Age group	IRR	p value	95% c.I lower	upper
12	Strong ACS conditions, urgent,	1	1.00	-	-	-
	Readmissions	2	0.50	0.000	0.36	0.58
		3	0.16	0.000	0.14	0.20
		4	0.06	0.000	0.05	0.07
		5	0.05	0.000	0.04	0.06
		6	0.12	0.000	0.10	0.14
		7	0.20	0.000	0.17	0.23
13	Strong ACS conditions, very urgent,	1	1.00	-	-	-
	All admissions	2	0.79	0.000	0.72	0.88
		3	0.35	0.000	0.32	0.39
		4	0.12	0.000	0.10	0.13
		5	0.08	0.000	0.08	0.09
		6	0.11	0.000	0.10	0.13
		7	0.16	0.000	0.14	0.18
14	Strong ACS conditions, very urgent,	1	1.00	-	-	-
	Readmissions	2	0.82	0.000	0.76	0.85
		3	0.26	0.000	0.23	0.27
		4	0.09	0.000	0.08	0.10
		5	0.08	0.000	0.07	0.09
		6	0.20	0.000	0.19	0.22
		7	0.45	0.000	0.44	0.51
15	Strong and weak markers, very urgent,	1	1.00	-	-	-
	All admissions	2	0.93	0.526	0.75	1.15
		3	1.07	0.456	0.88	1.31
		4	1.10	0.399	0.90	1.29
		5	0.76	0.008	0.63	0.93
		6	1.44	0.000	1.18	1.74
		7	3.23	0.000	2.667	3.93
16	Strong markers, very urgent,	1	1.00	-	-	-
	All admissions	2	1.01	0.945	0.80	1.25
		3	1.16	0.144	0.94	1.45
		4	1.16	0.139	0.95	1.40
		5	0.75	0.008	0.62	0.93
		6	1.40	0.001	1.66	1.74
		7	3.18	0.000	2.59	3.89
17	Admissions in surgical specialties	1	1.00	-	-	-
		2	1.35	0.000	1.26	1.45
		3	1.18	0.000	1.11	1.25
		4	0.95	0.113	0.88	1.01
		5	1.25	0.000	1.18	1.33
		6	2.22	0.000	2.09	2.57
		7	3.81	0.000	3.57	4.05
18	Admissions in medical specialties	1	1.00	-	-	-
		2	0.24	0.000	0.23	0.25
		3	0.07	0.000	0.07	0.08
		4	0.05	0.000	0.05	0.05
		5	0.09	0.000	0.08	0.09
		6	0.26	0.000	0.25	0.26
		7	0.51	0.000	0.49	0.52
19	Emergency admissions in surgical specialties	1	1.00	-	-	-
		2	.66	0.000	0.53	0.82
		3	1.13	0.187	0.93	1.40
		4	0.98	0.848	0.80	1.18
		5	0.99	0.991	0.83	1.20
		6	1.56	0.000	1.28	1.86
		7	2.93	0.000	2.42	3.54
20	Emergency admissions in medical specialties	1	1.00	-	-	-
		2	0.27	0.000	0.26	0.29
		3	0.09	0.000	0.09	0.10
		4	0.04	0.000	0.03	0.04
		5	0.05	0.000	0.04	0.05
		6	0.13	0.000	0.13	0.14
		7	0.36	0.000	0.35	0.38

Table 37 Continued

Admission Group	Description	Age group	IRR	p value	95% c.I lower	upper
21	**Admissions for ACS conditions Defined by Billings**	1	1.00	-	-	-
		2	0.75	0.213	0.48	1.17
		3	0.51	0.002	0.33	0.78
		4	0.36	0.000	0.23	0.55
		5	0.69	0.072	0.46	1.03
		6	3.06	0.000	2.07	4.52
		7	6.66	0.000	4.51	9.84
23	**Admissions for marker conditions Defined by Billings**	1	1.00	-	-	-
		2	0.77	0.504	0.28	2.12
		3	9.31	0.000	3.85	22.49
		4	8.72	0.000	3.61	21.06
		5	5.29	0.000	2.19	12.76
		6	14.56	0.000	6.05	35.07
		7	38.82	0.000	16.12	93.47

Group B EDs

The results show that the incremental relative risk ratios (IRRs) for ACS conditions generally showed a 'U' shaped pattern – that is higher values were seen in age groups 1 (under 1 year) and 7 (65-74) compared to the other groups. For all ACS admission groups (except admission group 10 – strong ACS conditions, readmissions) the IRRs were lower in most age groups (including age group 7) than age group 1 (aged under 1 year). For markers, the IRRs were approximately 3 times higher in age group 7 and age group 1. For medical and surgical admissions, the IRRs for age group 1 were higher than group 7 for medical admissions (groups 18 and 20), but lower for surgical admissions (groups 17 and 19). The strongest associations with age group 7 (65-74 years) were seen in admission groups 21 and 23 (Billings' ACS and markers) – in the latter group, the IRRs for age group 7 were 38 times higher than those for age group 1.

(iii) Sex

The next table shows the IRRs of sex group 2 (males) relative to group 1 (females).

Table 38 Incremental relative risk ratios, by sex, 1993/4

Admission Group	Description	Sex	IRR	p value	95% c.I lower	upper
1	Strong and weak ACS conditions, any urgency, all	1	1.00	-	-	-
		2	0.89	0.000	0.88	0.91
3	Strong and weak ACS conditions, any urgency, readmissions	1	1.00	-	-	-
		2	0.73	0.000	0.71	0.76
5	Strong and weak ACS conditions, urgent, all admissions	1	1.00	-	-	-
		2	0.75	0.000	0.73	0.77
7	Strong and weak ACS conditions, urgent, readmissions	1	1.00	-	-	-
		2	0.66	0.000	0.62	0.70
9	Strong ACS conditions, any urgency, all admissions	1	1.00	-	-	-
		2	0.91	0.000	0.89	0.94
10	Strong ACS conditions, any urgency, readmissions	1	1.00	-	-	-
		2	0.72	0.000	0.70	0.75
11	Strong ACS conditions, urgent, all admissions	1	1.00	-	-	-
		2	0.96	0.000	0.93	1.00
12	Strong ACS conditions, urgent, readmissions	1	1.00	-	-	-
		2	0.96	0.101	0.84	0.99
13	Strong ACS conditions, very urgent, all admissions	1	1.00	-	-	-
		2	0.88	0.000	0.84	0.99
14	Strong ACS conditions, very urgent, readmissions	1	1.00	-	-	-
		2	0.69	0.000	0.67	0.72
15	Strong and weak markers, very urgent, all admissions	1	1.00	-	-	-
		2	0.61	0.000	0.59	0.64
16	Strong markers, very urgent, all admissions	1	1.00	-	-	-
		2	0.60	0.000	0.58	0.63
17	Admissions in surgical specialties	1	1.00	-	-	-
		2	0.77	0.000	0.76	0.78
18	Admissions in medical specialties	1	1.00	-	-	-
		2	0.76	0.000	0.75	0.77
19	Emergency admissions in surgical specialties	1	1.00	-	-	-
		2	0.79	0.000	0.76	0.83
20	Emergency admissions in medical specialties	1	1.00	-	-	-
		2	0.79	0.000	0.77	0.82
21	Admissions for ACS conditions defined by Billings	1	1.00	-	-	-
		2	0.57	0.000	0.53	0.62
23	Admissions for marker conditions defined by Billings	1	1.00	-	-	-
		2	0.62	0.000	0.58	0.67

Group B EDs

Table 38 shows that for all admission groups the IRR was lower for males (sex = 2) than females (sex = 1). The IRRs were lower to a greater extent for males compared to females for the ACS admission groups representing readmissions (groups 3, 7, 10, 12, 14) relative to admissions (groups 1, 5, 9, 11, 13) and, apart from the Billings' ACS conditions, lowest for the marker admission groups (15 and 16), with the exception of group 21 (Billings' ACS conditions).

(iv) Access factors

GP access factor

Table 39 below shows the results for the GP access factor GAF2 using Group B EDs for 1993/4. In the table the results for GAF2q23 and GAF2q45 are shown relative to the baseline (GAF2q1 which takes a value of 1.000).

Table 39 Incremental risk ratios for GP access factor (GAF2), by admission group, 1993/4

Admission Group	Description	Access variable	IRR	p value	95% c.l lower	95% c.l upper
1	Strong and weak ACS conditions, any urgency, all admissions	gaf2q1	1.0000	-	-	-
		gaf2q23	1.0115	0.458	0.9812	1.0428
		gaf2q45	1.0236	0.203	0.9875	1.0609
3	Strong and weak ACS conditions, any urgency, readmissions	gaf2q1	1.0000	-	-	-
		gaf2q23	1.0053	0.872	0.9425	1.0723
		gaf2q45	0.9954	0.905	0.9231	1.0733
5	Strong and weak ACS conditions, urgent, all admissions	gaf2q1	1.0000	-	-	-
		gaf2q23	0.9945	0.833	0.9447	1.0468
		gaf2q45	1.0249	0.421	0.9652	1.0884
7	Strong and weak ACS conditions, urgent, readmissions	gaf2q1	1.0000	-	-	-
		gaf2q23	0.9610	0.431	0.8703	1.0611
		gaf2q45	0.9917	0.889	0.8831	1.1138
9	Strong ACS conditions, any urgency, all admissions	gaf2q1	1.0000	-	-	-
		gaf2q23	1.0592	0.028	1.0083	1.1449
		gaf2q45	1.1032	0.001	1.0391	1.1713
10	Strong ACS conditions, any urgency, readmissions	gaf2q1	1.0000	-	-	-
		gaf2q23	1.0128	0.687	0.9522	1.0772
		gaf2q45	1.0302	0.432	0.9565	1.1096
11	Strong ACS conditions, urgent, all admissions	gaf2q1	1.0000	-	-	-
		gaf2q23	1.0343	0.361	0.9620	1.1120
		gaf2q45	1.0734	0.099	0.9867	1.1678
12	Strong ACS conditions, urgent, readmissions	gaf2q1	1.0000	-	-	-
		gaf2q23	0.9903	0.901	0.8500	1.1538
		gaf2q45	1.0345	0.707	0.8666	1.2350

Table 39 Continued

Admission Group	Description	Access variable	IRR	p value	95% c.I lower	95% c.I upper
13	Strong ACS conditions, very urgent, all admissions	gaf2q1	1.0000	-	-	-
		gaf2q23	1.0224	0.634	0.9334	1.1198
		gaf2q45	1.0485	0.385	0.9423	1.1668
14	Strong ACS conditions, very urgent, readmissions	gaf2q1	1.0000	-	-	-
		gaf2q23	1.0195	0.555	0.9561	1.0872
		gaf2q45	1.0563	0.156	0.9794	1.1392
15	Strong and weak markers, very urgent, all admissions	gaf2q1	1.0000	-	-	-
		gaf2q23	0.9923	0.834	0.9233	1.0664
		gaf2q45	0.9702	0.496	0.8894	1.0584
16	Strong markers, very urgent, all admissions	gaf2q1	1.0000	-	-	-
		gaf2q23	0.9831	0.655	0.9125	1.0592
		gaf2q45	0.9465	0.233	0.8648	1.0359
17	Admissions in surgical specialties	gaf2q1	1.0000	-	-	-
		gaf2q23	0.9932	0.524	0.9728	1.0141
		gaf2q45	0.9939	0.630	0.9695	1.0190
18	Admissions in medical specialties	gaf2q1	1.0000	-	-	-
		gaf2q23	1.1305	0.000	1.1072	1.1541
		gaf2q45	1.0613	0.000	1.0352	1.0880
19	Emergency admissions in surgical specialties	gaf2q1	1.0000	-	-	-
		gaf2q23	0.9729	0.390	0.9139	1.0358
		gaf2q45	0.9619	0.332	0.8893	1.0404
20	Emergency admissions in medical specialties	gaf2q1	1.0000	-	-	-
		gaf2q23	1.0332	0.115	0.9921	1.0761
		gaf2q45	1.0358	0.172	0.9849	1.0893
21	Admissions for ACS conditions defined by Billings	gaf2q1	1.0000	-	-	-
		gaf2q23	0.9875	0.854	0.8632	1.1296
		gaf2q45	1.0329	0.689	0.8815	1.2103
23	Admissions for marker conditions defined by Billings	gaf2q1	1.0000	-	-	-
		gaf2q23	0.8556	0.006	0.7651	0.9568
		gaf2q45	0.8356	0.009	0.7298	0.9569

Group B EDs

For all admission groups except groups 9, 18, and 23, the IRRs for the GP access factor (GAF2) were not significant ($p < 0.05$). For admission group 23, there was a negative significant ($p < 0.01$) relationship between admissions and GAF2 suggesting that *higher* access to GPs was associated with a *lower* number of admissions for these marker conditions. There was a positive and significant ($p<0.001$) relationship between GAF2 and admissions in group 18 (admissions in medical specialties) although a non-significant relationship for admissions in group 20 (emergency admissions in medical specialties). The difference between group 18 and 20 is that group 18 included emergency and non-emergency admissions, while group 20 included only emergencies. These results could suggest that *increased* access to GP facilities might result in a *higher* level of admissions for non-emergency medical conditions. To test this further a separate analysis was carried out – a new admission group was created which was the number of admissions in group 18 (all medical admissions) *minus* those in group 20 (emergency medical admissions) – ie non-emergency medical admissions. The results for group 18, 20 and the new group are shown in the table below.

Table 40 **Incremental risk ratios (IRRs) of GP access factor (GAF2) for selected admission groups, 1993/4**

Admission Group	Description	Access Variable	IRR	p value	95% c.I lower	95% c.I upper
18	Admissions in medical specialties	Gaf2q1	1.0000	-	-	-
		Gaf2q23	1.1305	0.000	1.1072	1.1541
		Gaf2q45	1.0613	0.000	1.0352	1.0880
20	Emergency admissions in medical specialties	Gaf2q1	1.0000	-	-	-
		Gaf2q23	1.0332	0.115	0.9921	1.0761
		Gaf2q45	1.0358	0.172	0.9849	1.0893
New group	Non-emergency medical admissions	Gaf2q1	1.0000	-	-	-
		Gaf2q23	1.1631	0.000	1.1353	1.1915
		Gaf2q45	1.0741	0.000	1.0437	1.1092

Group B EDs

Table 40 shows that the results are slightly more pronounced using the new group (non-emergency medical admissions) – there is a significant ($p < 0.001$) positive relation with GP access factor. In the new group, the GP access factor does not behave linearly –that is, there is no evidence that GAF2q45 has a larger value than GAF2q23.

Hospital access factor (HAF2)

Table 41 below shows the results for the hospital access factor (HAF2) using Group B EDs for 1993/4. In the table the results for HAF2q23 and HAF2q45 are shown relative to the baseline (HAF2q1 which assumes a value of 1.000).

Table 41 **Incremental risk ratios for hospital access factor (HAF2), by admission group, 1993/4**

Admission Group	Description	Access variable	IRR	p value	95% c.l lower	95% c.l upper
1	Strong and weak ACS conditions, any urgency, all admissions	haf2q1	1.0000	-	-	-
		haf2q23	1.0928	0.000	1.0628	1.1237
		haf2q45	1.1221	0.000	1.0807	1.1443
3	Strong and weak ACS conditions, any urgency, readmissions	haf2q1	1.0000	-	-	-
		haf2q23	1.1073	0.001	1.0441	1.1743
		haf2q45	1.1471	0.000	1.0802	1.2182
5	Strong and weak ACS conditions, urgent, all admissions	haf2q1	1.0000	-	-	-
		haf2q23	1.0832	0.001	1.0338	1.1351
		haf2q45	1.1457	0.000	1.0922	1.2019
7	Strong and weak ACS conditions, urgent, readmissions	haf2q1	1.0000	-	-	-
		haf2q23	1.0545	0.251	0.9631	1.1548
		haf2q45	1.1892	0.000	1.0843	1.3042
9	Strong ACS conditions, any urgency, all admissions	haf2q1	1.0000	-	-	-
		haf2q23	1.1088	0.000	1.0579	1.1621
		haf2q45	1.1330	0.000	1.0798	1.1889
10	Strong ACS conditions, any urgency, readmissions	haf2q1	1.0000	-	-	-
		haf2q23	1.2242	0.000	1.1537	1.2991
		haf2q45	1.2307	0.000	1.1590	1.3069
11	Strong ACS conditions, urgent, all admissions	haf2q1	1.0000	-	-	-
		haf2q23	1.3010	0.000	1.0576	1.2075
		haf2q45	1.1775	0.000	1.1001	1.2603
12	Strong ACS conditions, urgent, readmissions	haf2q1	1.0000	-	-	-
		haf2q23	1.2561	0.002	1.0886	1.4494
		haf2q45	1.4299	0.000	1.2372	1.6526
13	Strong ACS conditions, very urgent, all admissions	haf2q1	1.0000	-	-	-
		haf2q23	1.1652	0.000	1.0711	1.2677
		haf2q45	1.2502	0.000	1.1472	1.3624
14	Strong ACS conditions, very urgent, readmissions	haf2q1	1.0000	-	-	-
		haf2q23	1.0807	0.010	1.0191	1.1461
		haf2q45	1.1672	0.000	1.0992	1.2393
15	Strong and weak markers, very urgent, all admissions	haf2q1	1.0000	-	-	-
		haf2q23	1.1030	0.004	1.0319	1.1789
		haf2q45	1.1119	0.002	1.0380	1.1909
16	Strong markers, very urgent, all admissions	haf2q1	1.0000	-	-	-
		haf2q23	1.0856	0.020	1.0133	1.1631
		haf2q45	1.0923	0.015	1.0174	1.1729
17	Admissions in surgical specialties	haf2q1	1.0000	-	-	-
		haf2q23	1.0955	0.000	1.0749	1.1166
		haf2q45	1.0704	0.000	1.0495	1.0917
18	Admissions in medical specialties	haf2q1	1.0000	-	-	-
		haf2q23	1.0925	0.000	1.0721	1.1133
		haf2q45	0.9618	0.000	0.9430	0.9810

Table 41 Continued

Admission Group	Description	Access variable	IRR	p value	95% c.I lower	95% c.I upper
19	Emergency admissions in surgical specialties	haf2q1	1.0000	-	-	-
		haf2q23	1.0749	0.017	1.0219	1.1408
		haf2q45	1.105	0.001	1.0392	1.1749
20	Emergency admissions in medical specialties	haf2q1	1.0000	-	-	-
		haf2q23	1.0879	0.000	1.0457	1.1319
		haf2q45	1.1436	0.000	1.0982	1.1908
21	Admissions for ACS conditions defined by Billings	haf2q1	1.0000	-	-	-
		haf2q23	1.0704	0.276	0.9472	1.2095
		haf2q45	1.0636	0.339	0.9373	1.2069
23	Admissions for marker conditions defined by Billings	haf2q1	1.0000	-	-	-
		haf2q23	1.0541	0.314	0.9514	1.1678
		haf2q45	1.1298	0.024	1.0161	1.2561

Group B EDs

Table 41 also shows that for almost all admission groups (except groups 21 and 23), there was a positive significant (p< or = 0.05) relationship between admissions and the hospital access factors (HAF2q23 and HAFq45 relative to HAF2q1). This suggests that admissions are greater with better access to hospital facilities. The IRR values suggest a dose-response relationship (with HAF2q45 generally being higher than HAF2q23) but since the confidence intervals for these variables overlapped in every case, the relationship may be spurious albeit suggestive. The IRR values for HAF2 were highest for admission groups 11 (strong ACS conditions, urgent, all admissions) and 12 (strong ACS conditions, urgent, readmissions).

There were similar results for the GP and hospital access factor for other years using Group B EDs (data not shown). The results for Group C EDs, which allow a better comparison across years, are shown in appendix F.

(v) Hospital service area.

The IRRs produced by the Poisson regression for HSAs are shown in the table below. Again Group B EDs are used. For simplicity, the results are shown only for 1993/4, and only for admission groups 1 (ACS) and 16 (markers). The results for other admission groups are shown in appendix G. The results for each HSA are shown relative to Barnet HSA, which assumes a value of 1.000.

Table 42 Incremental relative risk ratios (IRRs) for selected hospital service areas, and selected admission groups, 1993/4

Admission group	Description	Hospital Service Area	IRR	p value	95% c.l lower	95% c.l upper
1	Strong and weak ACS conditions, any urgency,	Barnet	1.0000	-	-	-
		Ealing	0.9665	0.000	0.9509	0.9823
	all admissions	Edgware	0.9925	0.233	0.9803	1.0048
		Hemel Hempstead	1.0097	0.036	1.0001	1.0189
		Hillingdon	0.9972	0.484	0.9897	1.0049
		Lister	0.9994	0.861	0.9924	1.0064
		Mt Vernon	1.0164	0.000	1.0099	1.0229
		Northwick Park	1.0067	0.007	1.0019	1.0116
		Queen Elizabeth II	0.9977	0.381	0.9926	1.0028
		St Mary's	0.9892	0.000	0.9849	0.9936
		Watford	1.0089	0.000	1.0051	1.0127
		West Middlesex	0.9982	0.342	0.9945	1.0019
16	Strong markers, very urgent, all admissions	Barnet	1.0000	-	-	-
		Ealing	0.9546	0.028	0.9158	0.9951
		Edgware	0.9902	0.539	0.9596	1.0217
		Hemel Hempstead	1.0034	0.767	0.9809	1.0265
		Hillingdon	0.9837	0.099	0.9648	1.0031
		Lister	1.0200	0.023	1.0027	1.0375
		Mt Vernon	1.0014	0.868	0.9850	1.0180
		Northwick Park	0.9815	0.004	0.9692	0.9940
		Queen Elizabeth II	1.0024	0.708	0.9899	1.0150
		St Mary's	0.9664	0.000	0.9552	0.9777
		Watford	1.0017	0.722	0.9922	1.0113
		West Middlesex	0.9884	0.017	0.9789	0.9979

Group B EDs

There are weak but significant relationships (positive and negative) in approximately half of the HSAs for each admission group, the other half having a non-significant relationship.

For ACS conditions (admission groups 1-14) there was no obvious pattern to the results – no HSA stood out as having a high or low IRR. The same was true for marker conditions (admission groups 15 and 16). However the IRR values were particularly low in Ealing and Hillingdon HSA (relative to Barnet) for emergency surgical (group 19) and emergency medical admissions (group 20).

A test for spatial correlation was performed (see chapter 2 on methodological implications), which was based on fitting a negative binomial model while allowing for extra-Poisson variation. The test indicated that there was significant spatial correlation. This means that, taking account of the variables in the model, a significant amount of so called 'extra-Poisson' variation existed between EDs which was not independent of spatial location. However, the test value of 1.2 indicated that the extent of spatial correlation was not big enough to be a problem in the analysis.

6.4 Discussion

(a) Methodological issues

In any study such as this, there are methodological limitations. Chief among these must be the limitations of using HES data for small area analyses of admissions groups for specific diagnoses, because the accuracy and completeness of these data are known to be suspect. However this study has gone further than most small area analyses in investigating the accuracy and completeness of the admissions dataset used – chapters 4, 5 and section 6.3.1 of chapter 6 describe extensive investigation – and precautions were taken as a result. For example of all the possible enumeration districts under study between a fifth and one half were finally used in different parts of the analysis. It was not possible to take into account the detailed results of the data accuracy study (described in chapter 5), for example in a sensitivity analysis, partly because it would have been difficult, if not misleading, to extrapolate the findings of the necessarily few ACS and marker conditions investigated in this study to the whole set of ACS conditions included in admissions groups 1-14. In future small area studies of individual ACS conditions, such as asthma and diabetes, methods might be developed so that coding accuracy can be taken into account more formally in the analysis.

If there were limitations with the numerator in this study, outlined above, there were also potential inaccuracies in the value of the denominator – the population size. The 1991 census was known to be incomplete in particular groups, for example young males in inner London. This was corrected as far as possible using adjustment factors recommended by the Office for National Statistics. It is not possible to know to what extent these adjustment factors are appropriate.

Another issue was how exactly to define hospital service areas. In this study EDs in which 40% or more admissions occurred at the hospital in question were included in the relevant hospital service area. Using a higher cut-off proportion (say 80%) might have produced different results, in particular possibly a more marked 'hospital effect' than that shown in table 42, but would have meant that large numbers of EDs were excluded from the analysis. Reviewing the literature on small area analyses, no consistent pattern is apparent in the definition of hospital service area; indeed most multivariate studies have not included HSA as a variable in the analysis.

The enumeration districts used in the study had an average population size of 429 – very small compared to that in an electoral ward of 10,000, or a district health authority of approximately 250,000. The most extensive small area analysis on the UK to date used small areas the size of electoral wards. The smaller enumeration districts were chosen in this study to reduce the potential for ecologic fallacy, and to be able to identify hospital service areas with more accuracy. But the drawback of a smaller area is that the variation in the number of relevant observations (admissions) is larger, thus increasing the potential for 'noise' to obscure relationships between variables. Again there is no right answer, except perhaps to repeat the analysis using electoral wards instead of EDs.

Assigning hospital admission records (coded by postcode) to EDs was not straightforward because not all postcodes (boundaries determined by the UK Post Office) uniquely map onto one ED (boundaries determined by the Office for National Statistics as part of the ten-yearly census). Therefore it might be that some admissions were assigned to EDs with inappropriate characteristics. However overall the number of postcodes this applied to was relatively small, and the problem is to a large extent intractable given that the way of geo-mapping the residence of census populations is different to that used for patients admitted to hospital.

Central to the investigation was the effect of the access factors on admissions for ACS and marker conditions. The formula used was complicated, drawing on routine sources of data. The basis of the formula to construct the GP access factor was the number of GPs in an area relative to the size of the population 'competing' for them, taking into account the distance of the population from the GPs. This is overly simplistic for at least four main reasons. First, it matters less to an individual how many GPs are available in the local area, than how accessible is *their own* GP, or the GPs in the practice in which they have registered. The availability of GPs in other practices may not affect this. Second, the number of full time equivalent GPs employed in a practice may be less important to access than, for example, the hours the GPs are available to patients. Third, access to a GP may be less of an issue than access to a GP with the appropriate knowledge of, and interest in, the ACS conditions concerned. Fourth, if a hypothesis is that access to primary care is relevant for the effective management of ACS conditions, then access to other relevant primary care staff and facilities may be more appropriate. However it would be very difficult to include these factors into a formula. For example, it is impossible to obtain from routine sources accurate data on opening hours and out-of-hours cover by GPs.

On the hospital access factor, there is arguably a better case for supposing that the supply of hospital resources (in this case beds) in different local hospitals is relevant to the accessibility of hospital care. Patients can in theory choose any hospital to visit for a consultation in the accident and emergency department, and the number of beds may be less important as a feature of access than the number of clinicians, the size of the accident and emergency unit or other on-site facilities, or the availability of public transport to the hospital. Some studies have demonstrated the importance of some of these factors, although the relative importance of each is not known. Again there should be further work on refining the quantification of access by developing the formula to include some of these variables.

In the multivariate analysis, Poisson regression was used but not more complicated techniques such as multi-level modelling (which probes more fully the effect of different 'layers' of characteristics - such as those relating to areas and institutions – on the dependent variable), or Bayesian analysis (which seeks to take account of the variation between areas due to proximity to each other), or two-stage least squares regression (which is purported to be more useful when examining the relationship between sets of variables when the direction of that relationship is two-way, eg high admissions resulting in a high supply of facilities, and vice versa (99)). All these were thought to beyond the immediate scope of this thesis, although investigation using these techniques could be a next stage of the analysis.

A large number of analyses were performed, for example using data referring to different years, to different admission groups, and different groups of EDs. If a large number of analyses are performed, then there is a greater possibility of finding significant results, even though there may be no significant relationships to be found. For example, using a 5% significance level, if 20 studies were performed based on random samples of data and in which there were no significant relationships, then one of the 20 studies would produce a significant result. In this study a balance was struck between conducting a thorough analysis, and not being at risk of finding a spurious result through conducting too many analyses. For example, in the multivariate analyses, results were presented mainly for one year only (1993/4) because the study in chapter 5 suggested that clinical coding of HES data was likely to be improving over time, and mainly for Group B EDs only (because Group B contained the largest number of EDs for which the GP access factors could be calculated).

(b) Substantive findings

(i) Univariate analyses and analysis by HSA

Need variables

The analysis showed that the area of North West Thames region under investigation had generally less socioeconomic deprivation compared to England and Wales as a whole apart from areas around St Mary's Hospital, Paddington, Ealing, Luton and West Middlesex Hospitals. More deprived enumeration districts also tended to be those with higher populations.

Much less variation across the region in values for SMR and SIR was found. Again, table 32 shows that the values were generally more favourable than for England & Wales as a whole. Low values for the SIR were found in EDs in St Mary's hospital service area in Paddington and also in Ealing - which are both relatively socially deprived areas. Why this should be so is not clear, but the finding might explain why the correlations between the need variables (shown in table 34) are also somewhat counter-intuitive. One might expect a positive and significant relationship between all three 'need' variables, but the table shows a non-significant relationship between the Carstairs and SMR scores and a weak negative relationship ($p = 0.005$) with SIR. The relationships may have been weakened by using quintiles rather than raw scores.

Access variables

There was a tendency for the mean values for the GP access factor to be higher in HSAs closer to central London, and lower in relatively rural areas, suggesting better access to the supply of general practitioners in and near central London. Similar results were found in 1991/2 and 1992/3 (data not shown).

For the hospital access factor (HAF2), the mean values were not obviously higher in HSAs closer to central London with the exception of St Mary's Paddington. This may due to the fact that competition for patient populations in London is more intense even though there are more hospitals in London.

Age-sex standardised rates

The ambulatory care sensitive (ACS) conditions and marker conditions selected for analysis represented a greater proportion of all admissions than those selected by Billings' *et al.* For example admission group 1 represented approximately 26% of all admissions per study year, and markers 4% compared to Billings' ACS conditions (1.18% of all admissions) and marker conditions (1.83%)(see table 25).

Using the conditions identified by Billings *et al* as being ACS, the rate across the region (using Group A EDs) was found to be 1.56 per 1000 population (see table 28). This is much lower than the 7.38 per 1000 found in Toronto and 15.19 in New York City in 1993 (1)(2). There could be many reasons for this. For example in this study, many small areas from inner-city London were excluded (because of inadequate data), leaving EDs largely from suburban or rural areas, in which illness levels, deprivation, and the availability of hospital facilities for example may be relatively low. Table 30 does indeed suggest that rates of admissions for ACS conditions were generally higher for hospital service areas nearer London. It may also be that the practice style of clinicians varies across the three countries, with physicians in the UK less likely to admit patients at a certain level of severity compared to their Canadian and US counterparts. It will be important to investigate this further.

Age-standardised rates for ACS conditions (admission group 1) increased from 28.09 to 30.74 between 1991/2 and 1993/4 (see table 29) – a rise of just over 9% - although the rates for markers were stable. A similar trend was found in New York City, in which rates for ACS conditions defined by Billings rose 28.3% from 1981-93 (2).

The proportion of readmissions to admissions tended to be higher in admission groups of strong ACS conditions (see table 25). This might suggest that a lack of timely and effective ambulatory care has a greater effect in increasing the risk of readmission for patients with strong ACS conditions.

(ii) Bivariate analyses

The relationship between indicators of need and access factors

The relationship between the SMR and SIR and the access factors was mostly not significant ($p>0.005$). In a health system based on the principle of equal access to equal need, this was a surprising finding, presuming that the access factors used really did measure access. However given the non-significant relationship between SMR and SIR with the Carstairs score, which is unexpected in small area analyses, it may be that the lack of association between the access indicators and SMR/SIR could be due to either measurement error in the calculation of the latter (especially the SIR, given the shortfall in the census data in inner London) or that the ED-based scores are unstable because of small populations. However there was a positive and significant ($p>0.0001$) relationship between Carstairs and both access scores (table 34), suggesting better access to GP and hospital facilities in deprived areas.

The relationship between indicators of need and admission rates

A significant ($p=0.01$) positive correlation was found between Carstairs scores and admission rates in all admission groups (except group 19 - emergency surgical admissions – for which the correlation was not significant). The effect was strongest in admission group 1 (ACS), but the correlation (0.325) was weaker than that found between the admission rates for ACS conditions (defined by Billings *et al)* and area income in the US (where between 60 and 70% of variation in ACS admission rates between areas could be explained by percentage of residents with an income below $15,000). Using Billings' *et al* ACS conditions, the correlation with Carstairs score in North West Thames was much weaker at 0.104.

A weak positive but significant ($p=0.01$) relation was found in North West Thames region between Carstairs scores and markers (groups 15 and 16). This was in contrast to New York City where the relationship between admission rates for markers and area income was not found to be significant.

Comparing the ratio of admission rates for the fifth most deprived EDs with the fifth least deprived in North West Thames region, the ratios varied for UK-defined ACS admission groups from 1.5 to 2.5 (see appendix 3). In contrast, the ratio of admission rates for Billings' ACS conditions between low and high income zip code areas in New York City was found to be higher at 3.4 in 1993, although it is not clear exactly how this ratio was calculated. It is not clear which features of socioeconomic deprivation are more relevant to admissions for ACS conditions: those included in the Carstairs index, or income. It may be that in the US, where a lack of health insurance may be the single biggest factor reducing access to primary care for those with ACS conditions, income is the better indicator of socioeconomic deprivation whereas in the UK the composite measure might be more relevant. It may be possible to test this in the UK, although data on the average income of residents of small areas are difficult to obtain.

In North West Thames, higher ratios of admission rates for the upper to the lower socioeconomic quintiles were observed in admission groups for readmissions. People living in socioeconomically deprived areas were particularly susceptible to readmission for ACS conditions. Among the many possible reasons are that hospitals serving more deprived populations may experience greater pressures to discharge patients from hospital before they are ready, or the quality of primary care may be deficient in these areas.

(iii) The multivariate analysis

Overall, only 10-20% of the variation between EDs in admissions for ACS conditions could be 'explained' by the model, and only 5% for marker conditions – so the model has limited explanatory power. This is in contrast to the analysis by Billings *et al* in which 60-70% of the variation between areas could be explained by area income. A large part of the explanation will be that the populations of the small areas were of the order of 450, whereas for Billings they were approximately 20,000 –30,000. But the results are consistent with the bivariate analysis: socioeconomic differences between individuals, as measured, are not as closely related to hospital admission rate in the UK than the US.

The test for dispersion also indicated a significant amount of extra-Poisson variation. This suggests that either the right variables were identified but the indicators used in the study were not good measures of them, or that other variables (not measured) influenced the variation. These other variables may be very different from those included, for example ethnicity or physician practice style (as suggested in the literature). A next step in the analysis might be to experiment using different variables for socioeconomic deprivation and access, before moving onto potentially interesting variables suggested in the literature as discussed in chapter 2.

There was a positive and significant relationship between the three need variables and all admission groups, and the relationship was stronger for admission groups representing readmissions. If admissions for ACS conditions do suggest inadequate upstream primary care, then the effect of the latter on readmissions is apparently greater. Perhaps some general practices are particularly poor at providing support to patients after discharge from hospital, possibly because of a lack of clinical skill, time, primary care staff working in the community, inadequate organisational arrangements to identify when patients registered with the practice are discharged from hospital, or inadequate support from social services locally.

The pattern of admissions by age was 'U'-shaped, as has been found elsewhere. The strongest age gradients were seen in Billings *et al's* ACS conditions (group 21) and markers (group 23) in age group 7 (65-74 years), in which the value of the IRR was six times higher (for group 21) and thirty eight times higher (for group 23). This may reflect that the conditions selected by Billings *et al* were more likely to be prevalent in this older age group. As expected, males had lower levels of admission than females, but this was especially true for readmissions. There may be a number of reasons for this. For example, older females are more likely to live alone without a live-in carer, than older males. All the admissions examined in this study however referred to those aged under 75 years.

The effect of the hospital access factor was positive and significant in almost all admission groups, indicating that the higher the availability of hospital beds to a population, the higher the admissions. In most admission groups there was a dose-response relationship, that is the higher the access to hospital facilities (as measured) the higher the admissions. The strength of the relationship was strongest for groups 11 (strong ACS, very urgent, admissions) and particularly group 12 (strong ACS, very urgent, readmissions). Access to hospital facilities appears to have a relatively strong positive effect on admissions for very urgent ACS conditions, whereas access to GPs appears to have a relatively strong positive effect on less urgent ACS and non-urgent medical conditions.

In almost all admission groups, the effect of the GP access factor was not significant. This access factor was found to have a significant if weak positive effect for admission group 9 (strong ACS conditions, any urgency), group 18 (all medical admissions) (weakly positive) and the new admission group (positive) – non-emergency medical admissions. In admission group 9 and 18 the effect of the GP access factor was linear – the higher the access to GPs the higher the admissions (in contrast to the hypothesis suggested in the introduction) – although in the non-emergency medical group the effect was not linear. The results suggest that people with non-urgent (and ACS) conditions are more likely to be admitted if they have greater access to general practitioners in primary care. Far from primary care preventing admission, it may be associated with higher levels of admission for non-urgent cases. The converse appears to be true for marker conditions, and admissions in surgical specialties, where a negative relation with access to general practitioner care was noted – that is lower access results in higher admissions – although only in one admission group (23) was the relationship significant. Again this is in contrast to the hypothesis suggested at the outset in chapter 1, and suggested by Billings *et al.* It may be that patients with marker conditions are either managed at home, possibly inappropriately, in areas with lower access to GP care, or that the conditions are not spotted in primary care before a fatality occurs (reducing the potential for admission), or that the GP access factor used in the study does not accurately measure access to primary care: each of these possibilities should be investigated further.

Because the access factors might exert different effects according to the age of patients admitted, for example in older people, the model was run for individual age groups (data not presented). The results suggest, in contrast to the US, that there were no marked differences in the influence of GP access factor or hospital access factors by age. It may be that although the types of conditions, and the severity of the conditions, experienced by age groups are different, the effect of age *per se* is small or negligible on overall hospitalisation. It might be expected, given the financing and organisation of the NHS, that older people would have similar levels of access to health care to younger people, in contrast to the United States. Although evidence in the UK does point to the greater difficulty experienced by older people in accessing primary care, for example in some rural areas, overall in North West Thames if this occurs the effect on hospitalisation rates does not appear to be great.

Finally the 'hospital effect' did not seem to be an important factor influencing variations in admissions between areas (see table 42). As noted above this may be because the hospital effect was blurred because of the way that EDs were assigned to HSAs. Further analysis using higher cut-off levels may be useful to see if the hospital effect becomes stronger and more significant.

Chapter 7 Summary of main findings, next steps, and implications for the NHS

Chapter outline

7.1 Context

This is the first study in the UK to consider variations in admission rates for ambulatory care sensitive (ACS) and marker conditions across small areas.

The area under study is a relatively wealthy part of the south-east of England, with small pockets of deprivation. The area covers parts of London.

Almost all of the population studied received health care provided by the national health service (NHS) which is financed and organised on the principle of equal access for equal need. A comprehensive range of benefits are available (including primary and secondary care) and care is largely free at the point of use. However there may be significant personal costs to individuals in using health care, for example cost of time off work, and cost of transportation to facilities. Most small area studies of ACS conditions have been conducted in the USA, in which there are significant numbers of the population without health insurance cover for basic care, including primary and secondary care. One study, noted in chapter 2, examined variations in ACS conditions (as defined by Billings *et al*) in Canada compared to the USA (2). As in the NHS, the Canadian health system provides universal access to health care and comprehensive benefits, with no incentives for providers to limit services to people with low incomes. But unlike the NHS, the Canadian system does require more co-payments at the point of use.

The analysis was of data from 1991-1994 – a time when there were many mergers of hospitals as a result of the 1991 NHS reforms, and when 10-30% of the general practices had joined the GP fundholding scheme. The merging of hospitals created problems in the identification of hospital service areas, and possibly in the completeness and accuracy of the hospital episode statistics dataset. Also, the GP fundholding scheme may have had an effect on the quality of ambulatory care, since prescription drugs and diagnostic tests were included in GP fundholders' budgets whereas admissions to hospital for medical conditions (largely ACS conditions) were not. There were new potential incentives therefore for GPs to reduce expenditure on pharmaceuticals and diagnostic tests which could have affected the management of patients with ACS conditions. However the evidence on the latter, although weak, is not suggestive (296).

7.2 Main findings

As others have shown (1)(22)(64)(65), it is possible for clinicians to achieve a consensus on which conditions may be ambulatory care sensitive and which are not. The study described in chapter 3 is the only one of its type published in the UK, and went further than previous studies in identifying not only ACS conditions but also the degree of sensitivity to ambulatory care and the likely urgency of admission. The study showed that general practitioners were more sanguine than their specialist colleagues as to the scope for preventing admissions through better management in ambulatory, particularly primary, care. A number of conditions were identified as being ACS, and there was similarity with those identified in American studies (see chapter 3 table 5) (1)(22)(64)(65).

The analysis of the completeness of the main dataset to be used in the small area analysis, described in chapter 4, was also unique to the small area variations literature (UK or US). Major shortcomings were found in the dataset and as a result a large number of areas, and years of data, were excluded from further analysis. Similarly the investigation of accuracy of the clinical coding of the admissions dataset was also unique to small area variations literature. Few good studies of this type have been conducted in the UK (284), yet the analysis showed major differences in coding between two sets of coders, including the coding for ACS conditions and markers. It was not possible to take account of most of the findings in the small area analysis.

Using Billings' list of ACS conditions, a much lower rate of admissions for ACS conditions was found in this study in the UK NHS (1.56 per 1000) than in New York City (15.16) or in Toronto (7.38). ACS admission rates increased over the three study years in this study, a trend also found by Billings in New York (1).

A significant positive relationship was found between admissions for ACS conditions and socioeconomic deprivation, independently of indicators of mortality and morbidity. However the relationship in the study between area *deprivation* and ACS admissions was much weaker than in the US or Canada between ACS admissions and area *income*. For example the ratio of admission rates for ACS conditions (as defined in the UK) of the most deprived compared to the least deprived areas in the UK was between 1.5 and 2.5 compared to 3.4 in the USA(using the ACS conditions defined by Billings). In the UK the relationship with deprivation was stronger for readmissions (for ACS conditions). In the USA, the main studies were not able to analyse readmissions separately. In contrast to findings in USA, a significant but weak relation was found between socioeconomic deprivation and admission rates for marker conditions.

The relationship between an indicator of access to primary care and admissions for ACS conditions was not significant, although weakly positive. The relationship reached statistical significance in a group representing 'strong' ACS conditions, and non-urgent medical conditions. In the USA, most small area studies of ACS conditions generally did not include an explicit measurement or analysis of access to primary care facilities. In three studies that did, two found a negative relationship between the supply of primary care physicians and admission rates (66)(123). However one of these ((123) found that, in a multivariate analysis, the negative association of supply of primary care with hospitalisation rates for ACS conditions was very weak. A third study found a negligible effect between ACS admission rates and the overall supply of physicians in an area (186), but this study was conducted in the Medicare population which, on the whole, enjoy significantly better access to health benefits than the rest of the US population, including primary care. The Medicare population, in this sense, is more similar than other population groups in the US to the population using NHS care in the UK. Bindman *et al* investigated a measure of *perceived* access to primary care (derived from self-rated responses to a community survey) and found that it was strongly and negatively associated with hospitalisation rates for the 5 ACS conditions studied (22).

Generally a positive relationship between admissions for ACS and marker conditions was found with the indicator of access to hospital care. This is in keeping with the overall findings elsewhere such as the small area analysis at the University of York (99).

While admission rates were found to be higher for the very young and those aged over 65 years, there was no obvious relationship with access to primary care and hospital care by age group. This is in contrast to the work by Billings *et al*, in which variations in admission rates across areas were less for these age groups compared to those aged 25-44 years (1).

The analysis suggested that there was a significant 'hospital effect' in some cases, but that this was not as strong as that found in the work by Tedeschi in the USA (173). This might be expected in a national health system in which most hospitals are owned, regulated, financed, and organised by the NHS.

The overall explanatory power of the multivariate model was weak at 10-20%, in contrast to the USA, where various investigators have found much stronger relationships between admission rates for ACS conditions and variables such as area income (1) and self-rated access to care (22). This will be largely due to the fact that the small areas used in this study were much smaller than those used in the US studies.

7.3 Next steps for analysis

There could be many further avenues of enquiry to build upon the early findings reported here. In the paragraphs below, the most important next steps are outlined.

First, the same analysis could be repeated using electoral wards as small areas rather than the smaller enumeration districts. This would reduce the amount of 'noise' at the cost of some loss of resolution in defining the hospital service areas.

Second, the unit of analysis could be changed from a small geographical area to GP practice, or primary care group, in which case the population registered with a practice (or PCG), rather than the residents of a geographically defined area, would be investigated. This might help to illuminate the relevant differences in access to primary care between patients from different practices, and the relevant components to access (for example number of nursing staff, or the opening hours of the practice). However it would create difficulties because indicators of population need would have to be calculated for each practice population. Some researchers have developed methods of doing this using census and other data (297), although such work is still fairly crude, and a number of demanding assumptions have to be made.

Third, as Billings *et al* have noted, access to care is still very much a 'black box' (1). It would be well worth conducting small scale qualitative studies to identify more fully the features which influence access to ambulatory care for patients living in areas of interest (perhaps those in which admission rates for ACS conditions are high). These features might include the *perceived* access of the population to ambulatory care, as investigated by Bindman *et al* (22).

Fourth, the GP access factor should be refined significantly, for example to take into consideration not just the supply of general practitioners in a practice and distance to them from the small area, but other factors such as the availability of other practice staff, opening hours, waiting time for a non-urgent appointment, or experience of the primary care staff in management of ACS conditions.

Fifth, conducting the analysis using a subset of common ACS conditions, for example asthma and diabetes, or single conditions may be fruitful. It may be that the factors influencing access to timely and effective ambulatory care for patients are condition specific. Similarly it may be worth focusing on readmissions for the full range of ACS conditions, since there may be factors affecting access that are specific to patients who have been discharged recently from hospital (for example access to care from social services departments).

Sixth, the list of ACS conditions developed in chapter 3 could be refined further, taking into account more recent evidence on the potential for ambulatory care to reduce the need for admission for various conditions.

Seventh, it might be useful to refine or add in other variables to the multivariate model, which have been suggested or examined by other investigators in the field. For example a priority might be to refine the variables used to indicate 'need'. This would not be easy, for the reasons outlined in chapter 2, but it might be possible to conduct a prospective study in which those cases admitted for ACS conditions might be investigated to assess their need (for example extent of ill health, or ability to benefit) for care, their socioeconomic status, or their ethnicity. Of all the possible new variables that could be included in a multivariate analysis, it would be worth exploring using GP consultation rates, or A&E attendances from the practice, for ACS conditions to investigate the relationship with admissions. At present this work would have to be done on a case study basis since data on these variables are not available routinely for large areas.

Eighth, there are some important methodological aspects of small area analysis that should be addressed, as outlined in chapter 2. In particular it would be helpful for guidelines to be drawn up on how best researchers might assess the influence of 'need' for care on variations in admission rates observed. Similarly helpful would be guidance on how best to measure the supply of resources in hospital or primary care, and their availability or accessibility to the relevant populations. Also if the variation in admission rates for ACS conditions is to be developed as a potential indicator of equity of access to primary or ambulatory care across different countries, then it would be helpful if a set of ACS conditions could be agreed internationally and drawn up using well recognised and explicit techniques. On the other hand, it may be that the conditions that are defined as ambulatory care sensitive are too country-specific to be developed and agreed across countries. For example agreement on a list of ambulatory care sensitive conditions may be influenced by the expectations of care, availability of treatments, clinical practice style of physicians, and system of financing and organising health care in a country.

7.4 Direct implications of the findings for the NHS

The implications of the findings from chapters 4 and 5 for the NHS are worrying. Information on hospital episode statistics is a potentially very valuable resource for all sorts of useful analyses, from economic evaluation to epidemiological investigation. Furthermore, unlike the case in Canada and the USA, NHS hospital episode statistics (HES) are reasonably comprehensive in that they cover the majority of hospital admissions for the population. While there is an increasing proportion of admissions to private providers (292), these are mostly for non-urgent surgery rather than for urgent or medical conditions. Although the NHS data investigated were from the early 1990's, when many hospitals were in the process of investing in new computerised information systems, it will be important to assess whether the situation is similar now. This is a matter of some urgency because HES are currently expensive to collect and grossly underused, given their significant potential to inform policy and practice. This is partly because of a lack of confidence in their accuracy which may not be completely justified.

The results of the main part of the study, at face value, suggest that in contrast to the USA, and to a much lesser extent Canada, access to ambulatory care is reasonably equitable in the

NHS. However, before policy-makers in the UK can relax, as the discussion above and in chapter 6 notes, the analysis represents a first small and tentative step into what could be a large area of investigation. Given the potential for admissions for ACS conditions to be an indicator of the quality of and access to ambulatory care (particularly primary care), it is important that further analysis along the lines suggested above be conducted.

Given the new developments in primary care, that is the formation of primary care groups and trusts which must now manage a budget for almost all the health care for their registered populations, scrutiny of the budget is likely to be on the agenda of all PCGs and PCTs in the future. Expenditures in the hospital sector will be the biggest call on these budgets, and so PCGs/PCTs have a bigger incentive than before to identify avoidable admissions and seek to reduce them where appropriate. Helping PCGs and PCTs to do this using a list of ACS conditions (and to investigate the reasons for variations) will become more relevant, and something that public health physicians in particular would be well-placed to lead and support. The fact that much information on activity in primary care (for example consultations by condition) is now available on computer, as is ambulatory care provided in accident in emergency departments, provides new opportunities for in-depth and creative local analysis.

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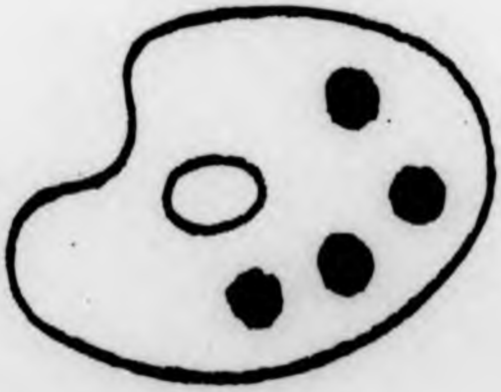
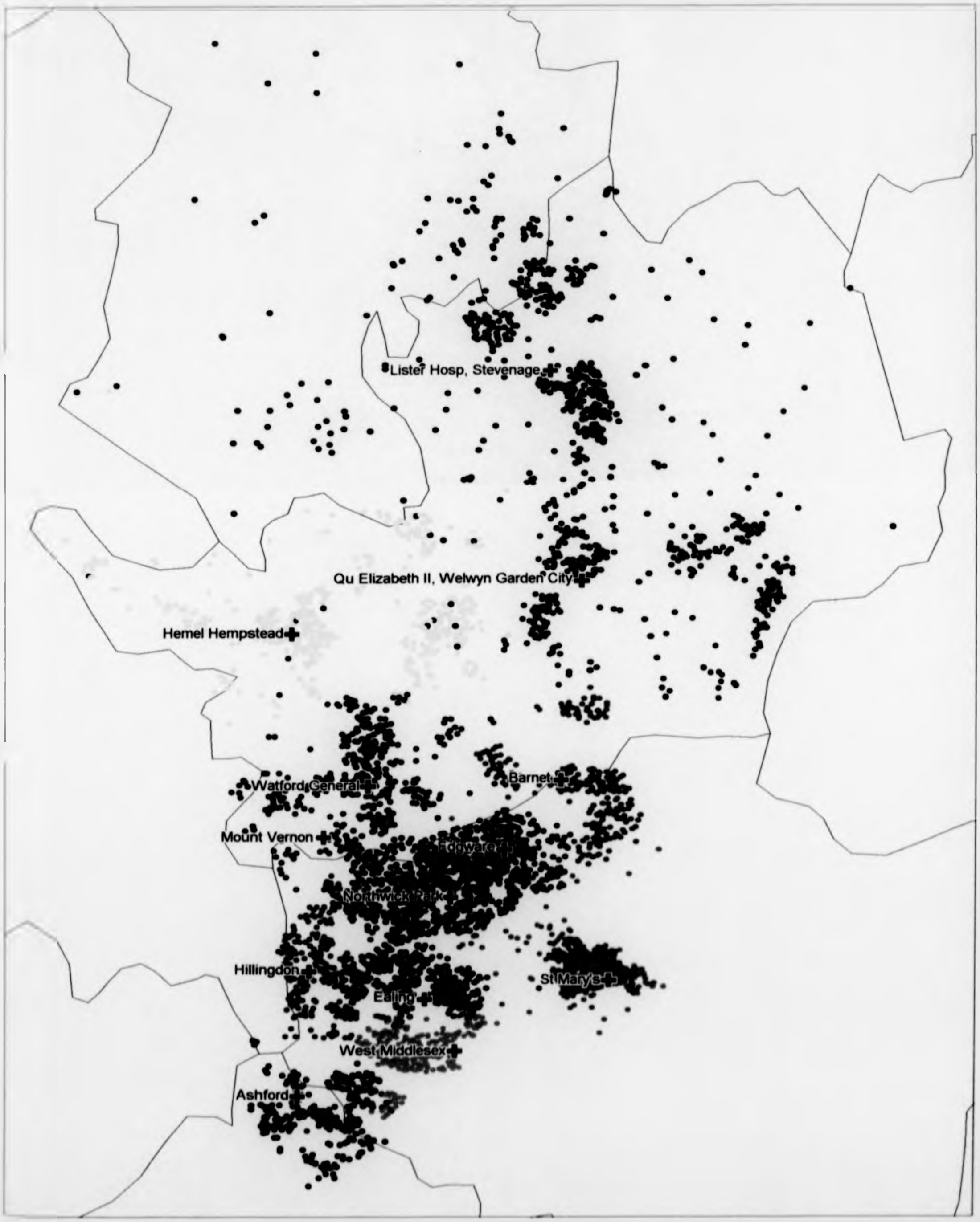


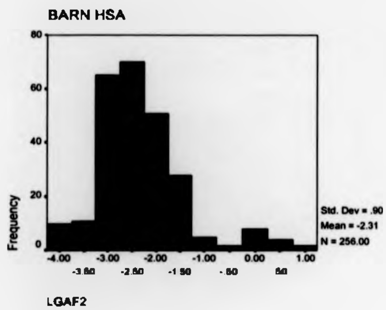
Appendix A - Hospital service areas 1993/4 using group A EDs

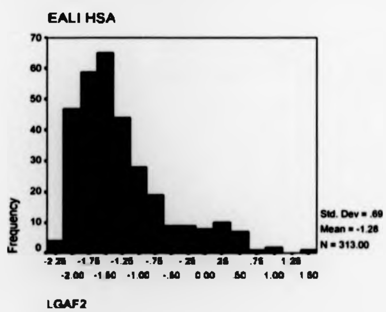


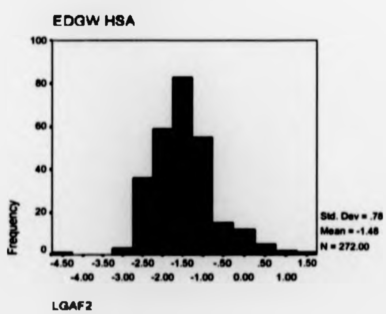
Appendix B 1/8

Frequency distribution of values for LGAF2 by HSA, 1993/4

(Group B EDs)

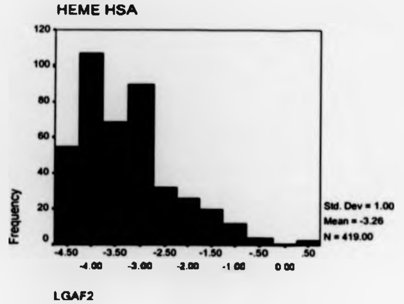


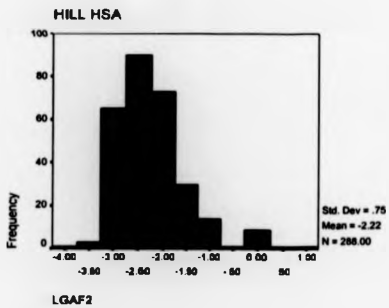


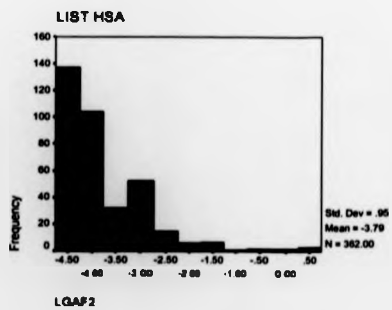


Frequency distribution of values for LGAF2 by HSA, 1993/4

(Group B EDs)

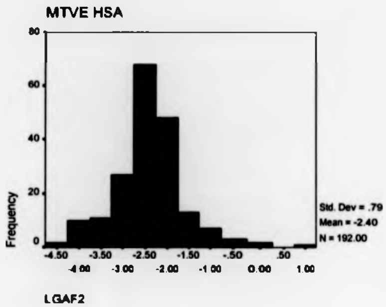


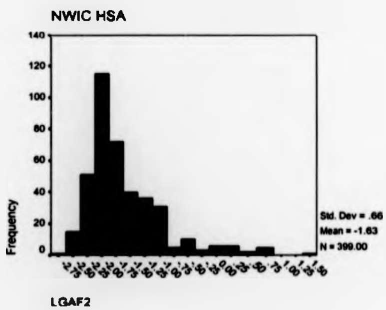


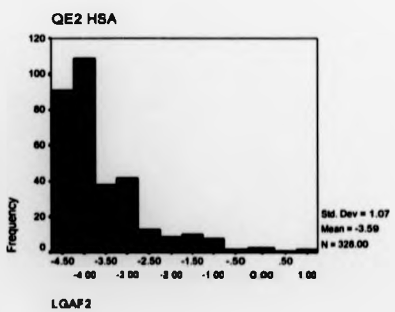


Frequency distribution of values for LGAF2 by HSA, 1993/4

(Group B EDs)

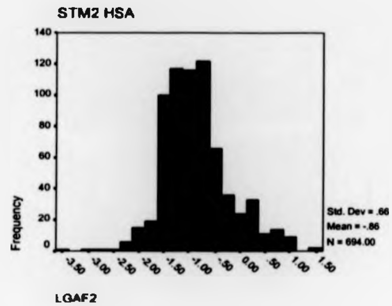


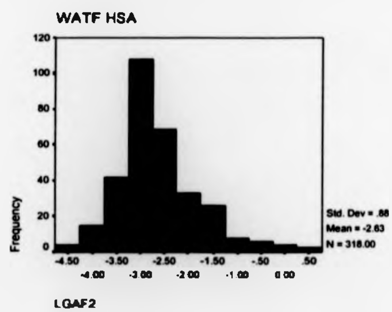


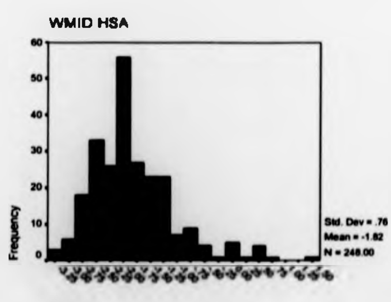


Frequency distribution of values for LGAF2 by HSA, 1993/4

(Group B EDs)





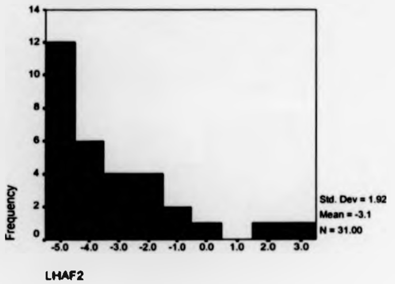


Appendix B 5/8

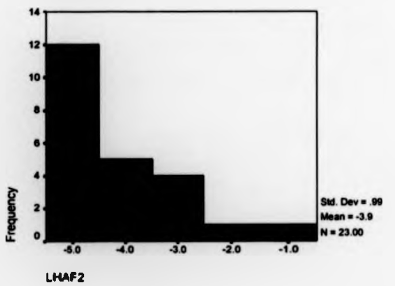
Frequency distribution of values for LHAF2 by HSA, 1993/4

(Group B EDs)

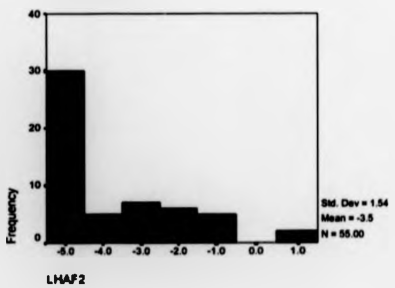
BARN HSA



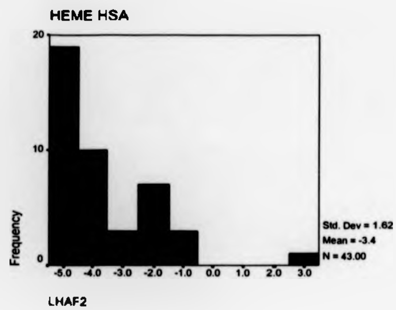
EALI HSA

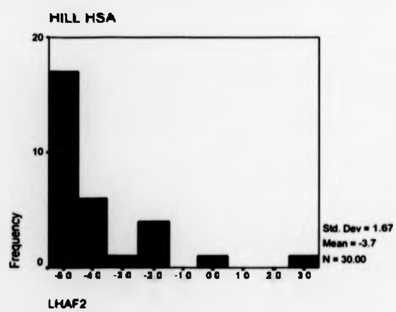


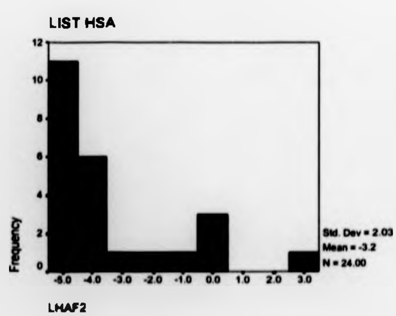
EDGW HSA



Frequency distribution of values for LHAF2 by HSA, 1993/4
(Group B EDs)

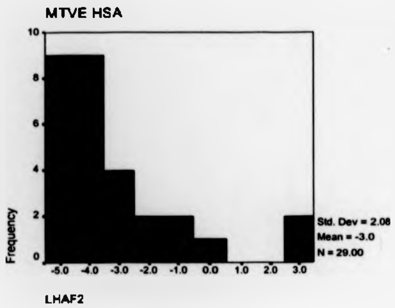


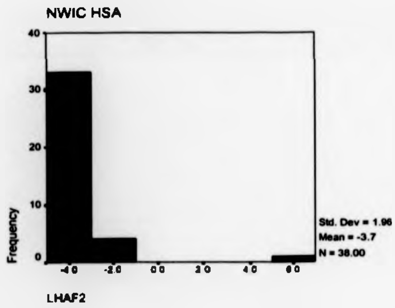


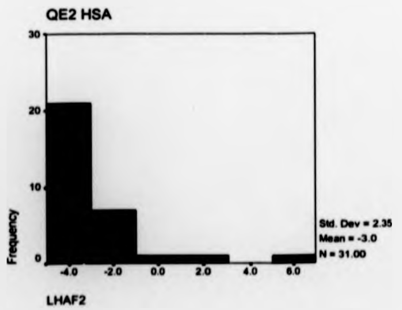


Frequency distribution of values for LHAF2 by HSA, 1993/4

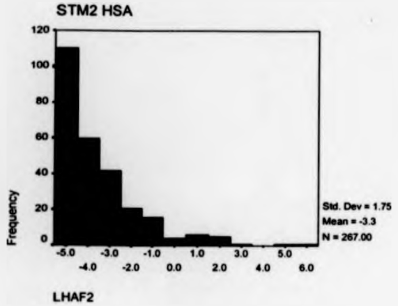
(Group B EDs)

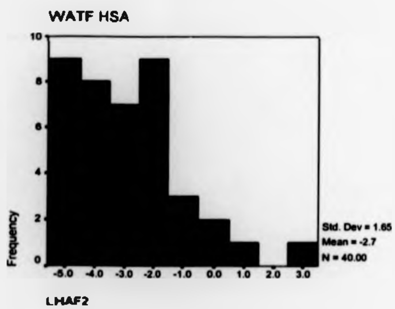


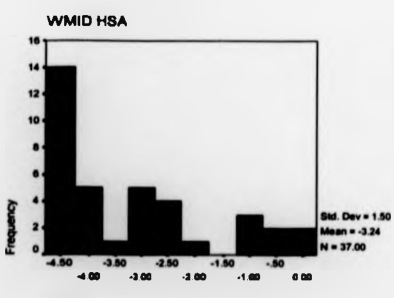




Frequency distribution of values for LHAF2 by HSA, 1993/4
(Group B EDs)







Ratio of means* of age-sex standardised admission rates by admission group, by year (* means = mean of the rates in the fifth most deprived EDs/ mean of the rates in the fifth least deprived EDs)

Admission group	Description	Ratio of means		
		912	923	934
1	Strong and weak ACS conditions, any urgency, all	1.66	1.66	1.79
3	Strong and weak ACS conditions, any urgency, readmissions	2.00	1.88	2.16
5	Strong and weak ACS conditions, urgent, all admissions	1.92	1.95	2.02
7	Strong and weak ACS conditions, urgent, readmissions	2.44	2.10	2.44
9	Strong ACS conditions, any urgency, all admissions	1.64	1.74	2.16
10	Strong ACS conditions, any urgency, readmissions	2.34	2.53	2.17
11	Strong ACS conditions, urgent, all admissions	1.76	1.88	2.17
12	Strong ACS conditions, urgent, readmissions	2.28	2.07	2.84
13	Strong ACS conditions, very urgent, all admissions	1.69	1.81	2.13
14	Strong ACS conditions, very urgent, readmissions	1.89	1.95	1.92
15	Strong and weak markers, very urgent, all admissions	1.60	1.71	1.46
16	Strong markers, very urgent, all admissions	1.58	1.67	1.47
17	Admissions in surgical specialties	1.39	1.37	1.45
18	Admissions in medical specialties	1.68	1.64	1.95
19	Emergency admissions in surgical specialties	0.95	0.77	1.12
20	Emergency admissions in medical specialties	1.14	0.80	1.27
21	Admissions for ACS conditions defined by Billings	2.04	2.09	1.80
23	Admissions for marker conditions defined by Billings	1.47	1.41	1.19

Group A EDs

The incremental relative risk ratio (IRR)* for key variables for admission group 1 (ACS), 1991/2

Variable	IRR*	P value	95% confidence interval
Carsq1	1.00	-	-
Carsq2	1.22	0.000	1.1674 - 1.2696
Carsq3	1.31	0.000	1.2535 - 1.3629
Carsq4	1.42	0.000	1.3598 - 1.4774
Carsq5	1.62	0.000	1.5523 - 1.6858
Smrq1	1.00	-	-
Smrq2	1.04	0.030	1.0041 - 1.0843
Smrq3	1.07	0.000	1.0335 - 1.1151
Smrq4	1.12	0.000	1.0793 - 1.1645
Smrq5	1.22	0.000	1.1773 - 1.2706
Slrq1	1.00	-	-
Slrq2	1.05	0.011	1.0114 - 1.0935
Slrq3	1.08	0.000	1.0414 - 1.1252
Slrq4	1.13	0.000	1.0873 - 1.1746
Slrq5	1.2	0.000	1.1546 - 1.2481
Gaf2q2	1.00	-	-
Gaf2q2	1.04	0.030	1.0041 - 1.0843
Gaf2q3	1.10	0.000	1.0528 - 1.1419
Gaf2q4	1.06	0.004	1.0196 - 1.1089
Gaf2q5	1.08	0.001	1.0323 - 1.1252
Gaf2q2	1.00	-	-
Haf2q2	1.14	0.000	1.0891 - 1.1952
Haf2q3	1.18	0.000	1.1191 - 1.2320
Haf2q4	1.16	0.000	1.1129 - 1.2183
Haf2q5	1.14	0.000	1.0921 - 1.1902

Group B EDs

* The IRRs are unadjusted for other variables in the model.

Appendix E 1/1

The value of 'pseudo r-squared' coefficients* using full and simplified models

Admission group	Model	Pseudo R-squared values		
		912	923	934
1	Full	0.1271	0.1282	0.1366
	Simplified	0.1254	0.1277	0.1354
3	Full	0.1216	0.126	0.1464
	Simplified	0.1194	0.1274	0.1454
5	Full	0.1560	0.1531	0.1599
	Simplified	0.1541	0.1522	0.1586
7	Full	0.1326	0.1366	0.1501
	Simplified	0.1304	0.1366	0.1489
9	Full	0.0548	0.0557	0.0573
	Simplified	0.0543	0.0553	0.0566
10	Full	0.1218	0.1425	0.1594
	Simplified	0.1199	0.1419	0.1588
11	Full	0.1003	0.0954	0.0948
	Simplified	0.0991	0.0942	0.0939
12	Full	0.1046	0.1016	0.1015
	Simplified	0.1014	0.0987	0.0999
13	Full	0.1327	0.1166	0.1144
	Simplified	0.1304	0.1162	0.1132
14	Full	0.1375	0.1377	0.135
	Simplified	0.1353	0.1374	0.1336
15	Full	0.0557	0.0557	0.0549
	Simplified	0.0550	0.0547	0.0547
16	Full	0.0531	0.0537	0.0518
	Simplified	0.0526	0.0526	0.0516
17	Full	0.1054	0.1196	0.1243
	Simplified	0.1035	0.1177	0.1232
18	Full	0.2150	0.2073	0.2334
	Simplified	0.2117	0.2056	0.232
19	Full	0.0920	0.1016	0.0654
	Simplified	0.0874	0.0986	0.0646
20	Full	0.2427	0.2317	0.2256
	Simplified	0.2382	0.2273	0.2236
21	Full	0.0980	0.1339	0.1379
	Simplified	0.0974	0.1331	0.1372
23	Full	0.1131	0.1116	0.0914
	Simplified	0.1102	0.1084	0.0911

* The pseudo r-squared values are adjusted using the variables representing: SMR; SIR; CARST; GAF2 and HAF2.

Incremental risk ratios for GP (GAF2) and hospital (HAF2) access factors, Group C EDs, by admission group, 1991/2, 1992/3, 1993/4

912					
Group	Access variable	Irr	p	95% c.I lower	95% c.I upper
1	gaf2q23	1.0819	0.001	1.0335	1.1327
	gaf2q45	1.0916	0.005	1.0264	1.1610
	haf2q23	1.1437	0.000	1.0866	1.2038
	haf2q45	1.1343	0.000	1.0765	1.1952
3	gaf2q23	1.0804	0.109	0.9830	1.1874
	gaf2q45	1.0572	0.390	0.9312	1.2002
	haf2q23	1.2419	0.000	1.1157	1.3823
	haf2q45	1.2078	0.001	1.0825	1.3477
5	gaf2q23	1.1458	0.000	1.0648	1.2329
	gaf2q45	1.1916	0.000	1.0810	1.3134
	haf2q23	1.0893	0.040	1.0039	1.1819
	haf2q45	1.0858	0.053	0.9989	1.1802
7	gaf2q23	1.1586	0.042	1.0056	1.3349
	gaf2q45	1.1623	0.118	0.9626	1.4036
	haf2q23	1.1476	0.093	0.9773	1.3475
	haf2q45	1.1827	0.044	1.0044	1.3928
9	gaf2q23	1.0677	0.098	0.9879	1.1541
	gaf2q45	1.0578	0.284	0.9544	1.1725
	haf2q23	1.0542	0.226	0.9678	1.1483
	haf2q45	1.0238	0.598	0.9380	1.1174
10	gaf2q23	1.0285	0.502	0.9214	1.1480
	gaf2q45	1.2192	0.007	1.0568	1.4065
	haf2q23	1.2113	0.002	1.0731	1.3673
	haf2q45	1.1329	0.049	1.0070	1.2826

923					
Group	Access variable	Irr	p	95% c.I Lower	95% c.I upper
1	gaf2q23	1.0663	0.000	1.0329	1.1008
	gaf2q45	1.0719	0.000	1.0308	1.1147
	haf2q23	1.0559	0.001	1.0235	1.0894
	haf2q45	1.0873	0.000	1.0526	1.1232
3	gaf2q23	1.0399	0.251	0.9725	1.1220
	gaf2q45	1.0733	0.087	0.9898	1.1639
	haf2q23	1.0434	0.202	0.9774	1.1138
	haf2q45	1.0821	0.022	1.0113	1.1579
5	gaf2q23	1.0513	0.054	0.9991	1.1063
	gaf2q45	1.1074	0.001	1.0405	1.1786
	haf2q23	1.0814	0.002	1.0285	1.137
	haf2q45	1.1533	0.000	1.0951	1.2146
7	gaf2q23	1.0275	0.595	0.9295	1.1359
	gaf2q45	1.1160	0.076	0.9884	1.2602
	haf2q23	1.0320	0.529	0.9354	1.1386
	haf2q45	1.1711	0.002	1.0587	1.2955
9	gaf2q23	1.0987	0.001	1.0419	1.1585
	gaf2q45	1.1599	0.000	1.0875	1.2371
	haf2q23	1.0947	0.001	1.0391	1.1532
	haf2q45	1.1405	0.000	1.0806	1.2039
10	gaf2q23	1.0736	0.046	1.0012	1.1513
	gaf2q45	1.1800	0.000	1.0839	1.2846
	haf2q23	1.0573	0.109	0.9876	1.1319
	haf2q45	1.1083	0.004	1.0324	1.1898

934					
Group	Access variable	Irr	p	95% c.I lower	95% c.I upper
1	gaf2q23	1.0424	0.078	0.9953	1.0917
	gaf2q45	1.0573	0.048	1.0004	1.1174
	haf2q23	1.0287	0.190	0.986	1.0732
	haf2q45	1.0764	0.001	1.0291	1.126
3	gaf2q23	1.0560	0.264	0.9597	1.162
	gaf2q45	1.1079	0.076	0.9894	1.2405
	haf2q23	1.1061	0.033	1.0083	1.2134
	haf2q45	1.1061	0.033	1.0083	1.2134
5	gaf2q23	1.0145	0.706	0.9413	1.0933
	gaf2q45	1.0835	0.078	0.9911	1.1846
	haf2q23	1.0200	0.570	0.9525	1.0924
	haf2q45	1.1194	0.002	1.0415	1.2032
7	gaf2q23	0.9773	0.758	0.8448	1.1307
	gaf2q45	1.1115	0.228	0.9358	1.3202
	haf2q23	0.9622	0.569	0.8427	1.0986
	haf2q45	1.1254	0.094	0.9799	1.2927
9	gaf2q23	1.0611	0.131	0.9824	1.1461
	gaf2q45	1.1165	0.018	1.0189	1.2235
	haf2q23	1.1008	0.008	1.0256	1.1816
	haf2q45	1.1588	0.000	1.0752	1.2489
10	gaf2q23	1.0687	0.173	0.9713	1.1759
	gaf2q45	1.1021	0.099	0.9819	1.2371
	haf2q23	1.0123	0.786	0.9264	1.1062
	haf2q45	1.1201	0.018	1.0199	1.2302

Appendix F 2/5

Incremental risk ratios for GP (GAF2) and hospital (HAF2) access factors, Group C EDs, by admission group, 1991/2, 1992/3, 1993/4

912						923						934					
Group	Access variable	Irr	p	95% c.l lower	95% c.l upper	Group	Access variable	Irr	p	95% c.l lower	95% c.l upper	Group	Access variable	Irr	p	95% c.l lower	95% c.l Upper
11	gaf2q23	1.0787	0.146	0.9739	1.1949	11	gaf2q23	1.0767	0.042	1.0025	1.1563	11	gaf2q23	1.0588	0.290	0.9523	1.1773
	gaf2q45	1.1289	0.083	0.9844	1.2945		gaf2q45	1.1191	0.002	1.0428	1.2009		gaf2q45	1.1229	0.070	0.9904	1.2731
	haf2q23	1.0228	0.697	0.9129	1.1459		haf2q23	1.211	0.000	1.1355	1.3129		haf2q23	1.0573	0.262	0.9591	1.1656
	haf2q45	1.0540	0.373	0.9387	1.1834		haf2q45	1.2210	0.000	1.1355	1.3129		haf2q45	1.1409	0.012	1.0297	1.264
12	gaf2q23	1.1638	0.176	0.9343	1.4498	12	gaf2q23	0.9856	0.862	0.8374	1.16	12	gaf2q23	1.0141	0.909	0.7977	1.2892
	gaf2q45	1.1198	0.441	0.8395	1.4936		gaf2q45	1.1822	0.085	0.9769	1.4306		gaf2q45	1.1600	0.292	0.9429	1.4606
	haf2q23	1.0474	0.712	0.8193	1.3390		haf2q23	1.2626	0.004	1.0752	1.4827		haf2q23	1.1735	0.152	0.9429	1.4606
	haf2q45	1.1004	0.451	0.8578	1.4115		haf2q45	1.4440	0.000	1.226	1.7009		haf2q45	1.3442	0.011	1.0713	1.6867
13	gaf2q23	1.0364	0.579	0.9131	1.1765	13	gaf2q23	1.0705	0.153	0.9749	1.1755	13	gaf2q23	1.0625	0.392	0.9246	1.2209
	gaf2q45	1.1679	0.071	0.9868	1.3821		gaf2q45	1.2017	0.001	1.0729	1.346		gaf2q45	1.1341	0.137	0.9608	1.3387
	haf2q23	1.0340	0.642	0.8977	1.1910		haf2q23	1.1775	0.001	1.0728	1.2923		haf2q23	1.0820	0.228	0.9518	1.2302
	haf2q45	1.0807	0.290	0.9360	1.2479		haf2q45	1.3604	0.000	1.2371	1.4961		haf2q45	1.2625	0.001	1.1048	1.4429
14	gaf2q23	1.1280	0.009	1.0310	1.2342	14	gaf2q23	1.0380	0.257	0.9731	1.1073	14	gaf2q23	1.0295	0.549	0.9361	1.1323
	gaf2q45	1.2533	0.000	1.1224	1.4121		gaf2q45	1.1321	0.002	1.046	1.2253		gaf2q45	1.1305	0.035	1.0085	1.2672
	haf2q23	1.0501	0.338	0.9501	1.1607		haf2q23	1.0829	0.014	1.016	1.1541		haf2q23	1.0101	0.821	0.9253	1.1027
	haf2q45	1.0569	0.290	0.9540	1.1709		haf2q45	1.1886	0.000	1.1131	1.2693		haf2q45	1.1444	0.004	1.0438	1.2548
15	gaf2q23	1.0857	0.141	0.9730	1.2114	15	gaf2q23	1.0317	0.396	0.9598	1.1091	15	gaf2q23	1.0203	0.708	0.9183	1.1335
	gaf2q45	1.1711	0.034	1.0123	1.3548		gaf2q45	0.9899	0.831	0.9021	1.0863		gaf2q45	1.0263	0.699	0.8997	1.1707
	haf2q23	1.0254	0.683	0.9086	1.1572		haf2q23	1.0456	0.220	0.9737	1.1228		haf2q23	0.9964	0.944	0.9039	1.0984
	haf2q45	1.0600	0.354	0.9369	1.1993		haf2q45	1.0045	0.906	0.9316	1.0832		haf2q45	1.0323	0.552	0.9295	1.1464
16	gaf2q23	1.0788	0.193	0.9624	1.2092	16	gaf2q23	1.0394	0.313	0.9641	1.1206	16	gaf2q23	1.0184	0.743	0.9131	1.1359
	gaf2q45	1.1656	0.047	1.0019	1.3559		gaf2q45	0.9934	0.894	0.9018	1.0942		gaf2q45	1.0253	0.720	0.8944	1.1752
	haf2q23	1.0330	0.610	0.9109	1.1722		haf2q23	1.0421	0.275	0.9676	1.1223		haf2q23	0.9804	0.702	0.886	1.0847
	haf2q45	1.0802	0.239	0.9499	1.2284		haf2q45	1.0019	0.961	0.9263	1.0837		haf2q45	1.0105	0.850	0.9062	1.1268

Incremental risk ratios for GP (GAF2) and hospital (HAF2) access factors, Group C EDs, by admission group, 1991/2, 1992/3, 1993/4

912					
Group	Access variable	Irr	p	95% c.I lower	95% c.I upper
17	gaf2q23	1.0568	0.000	1.0256	1.0889
	gaf2q45	1.0770	0.000	1.0333	1.1226
	haf2q23	1.0732	0.000	1.0380	1.1095
	haf2q45	1.0548	0.022	1.0193	1.0916
18	gaf2q23	1.1651	0.000	1.1589	1.2684
	gaf2q45	1.2124	0.000	1.1589	1.2684
	haf2q23	0.9752	0.171	0.9407	1.0109
	haf2q45	1.0283	0.138	0.9910	1.0670
19	gaf2q23	1.0267	0.529	0.9456	1.1147
	gaf2q45	1.0832	0.253	0.9445	1.2422
	haf2q23	1.1080	0.032	1.0087	1.217
	haf2q45	1.1466	0.006	1.041	1.263
20	gaf2q23	1.1536	0.000	1.0871	1.2242
	gaf2q45	1.0790	0.129	0.978	1.1034
	haf2q23	1.0309	0.378	0.9633	1.1034
	haf2q45	1.1788	0.000	1.1004	1.2627
21	gaf2q23	1.2130	0.061	0.9912	1.4844
	gaf2q45	1.1261	0.384	0.8619	1.4713
	haf2q23	0.9245	0.482	0.7426	1.1508
	haf2q45	0.9397	0.587	0.7507	1.1763
23	gaf2q23	1.2185	0.008	1.0528	1.4102
	gaf2q45	1.3568	0.002	1.1141	1.6525
	haf2q23	0.9823	0.827	0.8369	0.1529
	haf2q45	0.9805	0.816	0.831	1.1568

923					
Group	Access variable	Irr	p	95% c.I lower	95% c.I upper
17	gaf2q23	1.0392	0.000	1.0178	1.061
	gaf2q45	1.0135	0.319	0.987	1.0408
	haf2q23	1.0667	0.000	1.0451	1.0888
	haf2q45	1.0499	0.000	1.0274	1.0728
18	gaf2q23	1.2360	0.000	1.2118	1.2623
	gaf2q45	1.2379	0.000	1.2062	1.2705
	haf2q23	0.9360	0.000	0.9173	0.9551
	haf2q45	0.9477	0.000	0.9277	0.9682
19	gaf2q23	0.9973	0.926	0.9425	1.0552
	gaf2q45	0.8817	0.002	0.8143	0.9545
	haf2q23	1.0380	0.195	0.9807	1.0999
	haf2q45	0.9912	0.779	0.9323	1.0539
20	gaf2q23	1.0510	0.018	1.0087	1.0951
	gaf2q45	1.0329	0.245	0.978	1.0908
	haf2q23	1.0082	0.698	0.967	1.0513
	haf2q45	1.0968	0.000	1.0501	1.1454
21	gaf2q23	1.0072	0.914	0.8839	1.1477
	gaf2q45	1.0619	0.475	0.9005	1.252
	haf2q23	1.1341	0.054	0.9978	1.2891
	haf2q45	1.0412	0.562	0.9082	1.1935
23	gaf2q23	0.9784	0.682	0.8816	1.0858
	gaf2q45	0.9083	0.170	0.7916	1.0421
	haf2q23	1.0685	0.207	0.9639	1.1845
	haf2q45	1.0326	0.566	0.9254	1.1522

934					
Group	Access variable	Irr	p	95% c.I lower	95% c.I upper
17	gaf2q23	1.0078	0.615	0.9776	1.0389
	gaf2q45	0.9928	0.710	0.956	1.031
	haf2q23	1.0656	0.000	1.0364	1.0957
	haf2q45	1.0326	0.037	1.0019	1.0644
18	gaf2q23	1.2729	0.000	1.2378	1.3091
	gaf2q45	1.2816	0.000	1.2374	1.3274
	haf2q23	0.9568	0.001	0.9317	0.9826
	haf2q45	0.9762	0.103	0.9484	1.0048
19	gaf2q23	0.9948	0.907	0.9127	1.0844
	gaf2q45	0.9626	0.516	0.8581	1.0798
	haf2q23	1.0309	0.465	0.95	1.1188
	haf2q45	1.0073	0.873	0.9208	1.102
20	gaf2q23	1.0704	0.023	1.0095	1.1348
	gaf2q45	1.0725	0.071	0.9941	1.157
	haf2q23	0.9745	0.372	0.9208	1.0313
	haf2q45	1.0626	0.049	1.0002	1.129
21	gaf2q23	0.8535	0.114	0.7014	1.0385
	gaf2q45	1.0127	0.917	0.7975	1.2859
	haf2q23	1.0512	0.577	0.8819	1.253
	haf2q45	0.9514	0.616	0.7835	1.1554
23	gaf2q23	0.7919	0.005	0.6719	0.9335
	gaf2q45	0.7983	0.032	0.6501	0.9803
	haf2q23	1.0050	0.946	0.8695	1.1616
	haf2q45	1.0511	0.532	0.8989	1.2291

Group C EDs

Incremental risk ratios for GP (GAF2) and hospital (HAF2) access factors, by admission group, Group C EDs, all three years combined

912-934					
Group	Access variable	Irr	P	95% c.I lower	95% c.I upper
1	gaf2q23	1.0687	0.000	1.0413	1.0967
	gaf2q45	1.0406	0.015	1.0076	1.0746
	haf2q23	1.0714	0.000	1.0435	1.0999
	haf2q45	1.0763	0.000	1.0474	1.1061
3	gaf2q23	1.0533	0.060	0.9978	1.112
	gaf2q45	1.0259	0.450	0.9599	1.0964
	haf2q23	1.0895	0.002	1.0313	1.151
	haf2q45	1.0893	0.003	1.029	1.1531
5	gaf2q23	1.0753	0.001	1.0318	1.1208
	gaf2q45	1.1094	0.000	1.0543	1.1675
	haf2q23	1.0751	0.001	1.0307	1.1214
	haf2q45	1.1115	0.000	1.0641	1.1609
7	gaf2q23	1.0689	0.106	0.9858	1.1591
	gaf2q45	1.1090	0.014	1.0042	1.2247
	haf2q23	1.0558	0.197	0.9721	1.1467
	haf2q45	1.1498	0.001	1.0563	1.2517
9	gaf2q23	1.0799	0.001	1.0341	1.1278
	gaf2q45	1.0994	0.000	1.0424	1.1595
	haf2q23	1.0726	0.002	1.0264	1.1208
	haf2q45	1.0817	0.001	1.0336	1.1322
10	gaf2q23	1.0497	0.102	0.9903	1.1127
	gaf2q45	1.1079	0.005	1.0316	1.19
	haf2q23	1.0619	0.045	1.0013	1.1262
	haf2q45	1.0526	0.100	0.9902	1.1189
11	gaf2q23	1.0708	0.021	1.0104	1.1347
	gaf2q45	1.1340	0.001	1.0561	1.2176
	haf2q23	1.0841	0.008	1.0216	1.1503
	haf2q45	1.1520	0.000	1.0838	1.2244
12	gaf2q23	1.0441	0.512	0.9175	1.882
	gaf2q45	1.1733	0.042	1.0058	1.3686
	haf2q23	1.1979	0.008	1.0484	1.3687
	haf2q45	1.3265	0.000	1.158	1.5196
13	gaf2q23	1.0577	0.140	0.9816	1.1397
	gaf2q45	1.2007	0.000	1.096	1.3154
	haf2q23	1.1350	0.001	1.0509	1.2259
	haf2q45	1.2675	0.000	1.1716	1.3712
14	gaf2q23	1.0635	0.020	1.0096	1.1202
	gaf2q45	1.1663	0.000	1.094	1.2434
	haf2q23	1.1386	0.000	1.0779	1.2027
	haf2q45	1.1386	0.000	1.0779	1.2027
15	gaf2q23	1.0330	0.285	0.9732	1.0965
	gaf2q45	1.0406	0.304	0.9645	1.1226
	haf2q23	1.0120	0.699	0.9524	1.0753
	haf2q45	1.0040	0.990	0.9389	1.0659
16	gaf2q23	1.0354	0.271	0.9731	1.1017
	gaf2q45	1.0471	0.253	0.9676	1.133
	haf2q23	1.0107	0.741	0.9488	1.0765
	haf2q45	1.0050	0.880	0.9409	1.0736

Incremental risk ratios for GP (GAF2) and hospital (HAF2) access factors, by admission group, Group C EDs, all three years combined

912-934					
Group	Access variable	irr	p	95% c.l lower	95% c.l upper
17	gaf2q23	1.0399	0.000	1.0224	1.0576
	gaf2q45	1.0060	0.589	0.9843	1.0281
	haf2q23	1.0603	0.000	1.0422	1.0788
	haf2q45	1.0356	0.000	1.017	1.0545
18	gaf2q23	1.2093	0.000	1.1888	1.2302
	gaf2q45	1.1501	0.000	1.1251	1.1757
	haf2q23	0.9233	0.000	0.9074	0.9395
	haf2q45	0.9309	0.000	0.9141	0.9481
19	gaf2q23	1.0120	0.610	0.9666	1.0596
	gaf2q45	0.8654	0.000	0.8095	0.9252
	haf2q23	1.0497	0.048	1.003	1.1015
	haf2q45	1.0215	0.633	0.962	1.0656
20	gaf2q23	1.0682	0.000	1.0331	1.1045
	gaf2q45	1.0237	0.497	0.9773	1.0483
	haf2q23	1.0122	0.497	0.9773	1.0483
	haf2q45	1.1125	0.000	1.0729	1.1535
21	gaf2q23	1.0316	0.573	0.9257	1.1498
	gaf2q45	1.0767	0.286	0.94	1.2333
	haf2q23	1.0364	0.523	0.9287	1.1566
	haf2q45	0.9962	0.949	0.8878	1.1179
23	gaf2q23	1.0457	0.294	0.9618	1.1369
	gaf2q45	1.0682	0.234	0.9582	1.909
	haf2q23	1.0407	0.361	0.9552	1.1337
	haf2q45	1.0251	0.588	0.9368	1.1218

Group C EDs

Incremental relative risk ratios (IRRs) for selected hospital service areas, and for selected admission groups,1993/4

3	Strong and weak ACS conditions, any urgency, Readmissions	Barnet	1.0000	-	-	-
		Ealing	0.9441	0.001	0.9125	0.9767
		Edgware	1.0180	0.162	0.9929	1.0438
		Hemel Hempstead	0.9881	0.223	0.9693	1.0073
		Hillingdon	1.0016	0.838	0.9861	1.0174
		Lister	1.0033	0.656	0.9888	1.0180
		Mt Vernon	1.0173	0.012	1.0038	1.0309
		Northwick Park	1.0183	0.000	1.0083	1.0284
		Queen Elizabeth II	0.9939	0.264	0.9833	1.0046
		St Mary's	0.9957	0.343	0.9867	1.0046
		Watford	1.0117	0.003	1.0039	1.0195
		West Middlesex	0.9952	0.223	0.9876	1.0029
5	Strong and weak ACS conditions, urgent, all admissions	Barnet	1.0000	-	-	-
		Ealing	0.9876	0.346	0.9623	1.0136
		Edgware	0.9872	0.208	0.9676	1.0072
		Hemel Hempstead	0.9699	0.000	0.9551	0.9848
		Hillingdon	0.9890	0.082	0.9768	1.0014
		Lister	1.0077	0.188	0.9963	1.0192
		Mt Vernon	1.0016	0.772	0.9908	1.0125
		Northwick Park	1.0111	0.005	1.0033	1.0191
		Queen Elizabeth II	0.9925	0.079	0.9841	1.0008
		St Mary's	0.9857	0.000	0.9787	0.9928
		Watford	1.0044	0.162	0.9982	1.0105
		West Middlesex	0.9814	0.000	0.9752	0.9876
7	Strong and weak ACS conditions, urgent, Readmissions	Barnet	1.0000	-	-	-
		Ealing	0.9480	0.038	0.9014	0.9972
		Edgware	0.9723	0.155	0.9353	1.0107
		Hemel Hempstead	0.9613	0.009	0.9334	0.9901
		Hillingdon	0.9873	0.293	0.9641	1.0111
		Lister	1.0090	0.419	0.9873	1.0312
		Mt Vernon	1.0136	0.195	0.9931	1.0344
		Northwick Park	1.0103	0.181	0.9952	1.0255
		Queen Elizabeth II	0.9808	0.022	0.9648	0.9972
		St Mary's	0.9838	0.019	0.9704	0.9973
		Watford	1.0081	0.178	0.9964	1.0199
		West Middlesex	0.9716	0.000	0.9597	0.9836
9	Strong ACS conditions, any urgency, all admissions	Barnet	1.0000	-	-	-
		Ealing	0.9770	0.087	0.9513	1.0034
		Edgware	0.9759	0.022	0.9558	0.9964
		Hemel Hempstead	0.9977	0.768	0.9824	1.0131
		Hillingdon	0.9939	0.347	0.9814	1.0066
		Lister	1.0065	0.274	0.9948	1.0184
		Mt Vernon	1.0294	0.000	1.0186	1.0402
		Northwick Park	1.0112	0.006	1.0032	1.0193
		Queen Elizabeth II	0.9994	0.885	0.9908	1.0080
		St Mary's	1.0018	0.614	0.9947	1.0090
		Watford	1.0177	0.000	1.0115	1.0240
		West Middlesex	0.9909	0.004	0.9847	0.9972

Incremental relative risk ratios (IRRs) for selected hospital service areas, and for selected admission groups,1993/4

10	Strong ACS conditions, any urgency, Readmissions	Barnet	1.0000	-	-	-
		Ealing	1.0059	0.756	0.9692	1.0440
		Edgware	1.0313	0.033	1.0025	1.0609
		Hemel Hempstead	1.1282	0.000	1.1057	1.1511
		Hillingdon	1.0467	0.000	1.0289	1.0648
		Lister	1.0473	0.000	1.0309	1.0638
		Mt Vernon	1.0427	0.000	1.0275	1.0580
		Northwick Park	1.0237	0.000	1.0122	1.0353
		Queen Elizabeth II	1.0277	0.000	1.0161	1.0396
		St Mary's	1.0006	0.902	0.9907	1.0107
		Watford	1.0398	0.000	1.0311	1.0485
		West Middlesex	0.9906	0.038	0.9817	0.9995
11	Strong ACS conditions, urgent, all admissions	Barnet	1.0000	-	-	-
		Ealing	1.0094	0.603	0.9744	1.0458
		Edgware	0.9795	0.145	0.9526	1.0072
		Hemel Hempstead	0.9640	0.001	0.9435	0.9849
		Hillingdon	0.9733	0.003	0.9564	0.9906
		Lister	1.0080	0.326	0.9921	1.0242
		Mt Vernon	0.9947	0.496	0.9796	1.0100
		Northwick Park	1.0151	0.006	1.0043	1.0261
		Queen Elizabeth II	0.9873	0.036	0.9755	0.9991
		St Mary's	0.9863	0.006	0.9765	0.9961
		Watford	1.0113	0.008	1.0029	1.0198
		West Middlesex	0.9736	0.000	0.9649	0.9823
12	Strong ACS conditions, urgent, Readmissions	Barnet	1.0000	-	-	-
		Ealing	0.9004	0.004	0.8384	0.9670
		Edgware	0.9136	0.002	0.8637	0.9665
		Hemel Hempstead	0.9573	0.043	0.9177	0.9986
		Hillingdon	0.9235	0.000	0.8911	0.9570
		Lister	0.9669	0.044	0.9357	0.9991
		Mt Vernon	0.9919	0.593	0.9626	1.0220
		Northwick Park	1.0010	0.926	0.9803	1.0221
		Queen Elizabeth II	0.9518	0.000	0.9278	0.9765
		St Mary's	0.9666	0.001	0.9478	0.9857
		Watford	0.9984	0.850	0.9821	1.1050
		West Middlesex	0.9415	0.000	0.9240	0.9594
13	Strong ACS conditions, very urgent, all admissions	Barnet	1.0000	-	-	-
		Ealing	0.9829	0.449	0.9401	1.0278
		Edgware	0.9599	0.023	0.9268	0.9943
		Hemel Hempstead	0.9822	0.182	0.9566	1.0085
		Hillingdon	0.9545	0.000	0.9335	0.9760
		Lister	0.9948	0.613	0.9750	1.0150
		Mt Vernon	0.9960	0.678	0.9771	1.0151
		Northwick Park	0.9922	0.266	0.9787	1.0060
		Queen Elizabeth II	0.9754	0.002	0.9606	0.9905
		St Mary's	0.9711	0.000	0.9588	0.9835
		Watford	1.0104	0.050	1.0000	1.0210
		West Middlesex	0.9695	0.000	0.9588	0.9803

Incremental relative risk ratios (IRRs) for selected hospital service areas, and for selected admission groups,1993/4

14	Strong ACS conditions, very urgent, Readmissions	Barnet	1.0000	-	-	-
		Ealing	0.9759	0.140	0.9448	1.0080
		Edgware	0.9763	0.060	0.9522	1.0010
		Hemel Hempstead	0.9768	0.015	0.9586	0.9954
		Hillingdon	0.9709	0.000	0.9557	0.9863
		Lister	1.0054	0.455	0.9913	1.0197
		Mt Vernon	0.9957	0.540	0.9823	1.0094
		Northwick Park	0.9948	0.303	0.9851	1.0047
		Queen Elizabeth II	0.9837	0.003	0.9733	0.9942
		St Mary's	0.9721	0.000	0.9633	0.9810
		Watford	1.0007	0.854	0.9931	1.0084
		West Middlesex	0.9801	0.000	0.9725	0.9877
15	Strong and weak markers, very urgent, all admissions	Barnet	1.0000	-	-	-
		Ealing	0.9530	0.018	0.9158	0.9918
		Edgware	0.9887	0.459	0.9594	1.0189
		Hemel Hempstead	1.0019	0.861	0.9802	1.0241
		Hillingdon	0.9839	0.090	0.9657	1.0025
		Lister	1.0218	0.010	1.0052	1.0387
		Mt Vernon	1.0001	0.988	0.9844	1.0161
		Northwick Park	0.9794	0.001	0.9676	0.9914
		Queen Elizabeth II	1.0021	0.737	0.9900	1.0142
		St Mary's	0.9648	0.000	0.9540	0.9756
		Watford	1.0000	0.995	0.9909	1.0092
		West Middlesex	0.9871	0.006	0.9781	0.9963
17	Admissions in surgical specialties	Barnet	1.0000	-	-	-
		Ealing	0.9652	0.000	0.9544	0.9761
		Edgware	0.9796	0.000	0.9712	0.9881
		Hemel Hempstead	0.9896	0.001	0.9834	0.9958
		Hillingdon	0.9924	0.005	0.9872	0.9977
		Lister	1.0132	0.000	1.0084	1.0180
		Mt Vernon	0.9979	0.365	0.9934	1.0024
		Northwick Park	0.9811	0.000	0.9777	0.9845
		Queen Elizabeth II	1.0037	0.031	1.0003	1.0071
		St Mary's	0.9837	0.000	0.9806	0.9867
		Watford	0.9966	0.011	0.9940	0.9992
		West Middlesex	0.9925	0.000	0.9899	0.9951
18	Admissions in medical specialties	Barnet	1.0000	-	-	-
		Ealing	1.0494	0.000	1.0368	1.0621
		Edgware	1.0472	0.000	1.0376	1.0569
		Hemel Hempstead	1.0225	0.000	1.0156	1.0296
		Hillingdon	1.0518	0.000	1.0460	1.0577
		Lister	1.1038	0.000	1.0985	1.1091
		Mt Vernon	1.0389	0.000	1.0341	1.0438
		Northwick Park	1.0282	0.000	1.0245	1.0319
		Queen Elizabeth II	1.0124	0.000	1.0086	1.0162
		St Mary's	1.0796	0.000	1.0763	1.0829
		Watford	1.0232	0.000	1.0203	1.0260
		West Middlesex	1.0063	0.000	1.0035	1.0092

Incremental relative risk ratios (IRRs) for selected hospital service areas, and for selected admission groups,1993/4

19	Emergency admissions in surgical specialties	Barnet	1.0000	-	-	-
		Ealing	0.7429	0.000	0.7086	0.7788
		Edgware	1.0599	0.000	1.0306	1.0901
		Hemel Hempstead	1.0343	0.001	1.0130	1.0560
		Hillingdon	0.8320	0.000	0.8117	0.8527
		Lister	1.0851	0.000	1.0689	1.1016
		Mt Vernon	0.9405	0.000	0.9236	0.9577
		Northwick Park	1.0128	0.029	1.0013	1.0244
		Queen Elizabeth II	1.0419	0.000	1.0306	1.0534
		St Mary's	0.9672	0.000	0.9566	0.9778
		Watford	1.0198	0.000	1.0111	1.0287
		West Middlesex	0.9940	0.193	0.9851	1.0030
20	Emergency admissions in medical specialties	Barnet	1.0000	-	-	-
		Ealing	0.6917	0.000	0.6683	0.7159
		Edgware	1.1425	0.000	1.1220	1.1634
		Hemel Hempstead	1.0749	0.000	1.0600	1.0900
		Hillingdon	0.7932	0.000	0.7785	0.8083
		Lister	1.0925	0.000	1.0814	1.1038
		Mt Vernon	0.9778	0.000	0.9666	0.9891
		Northwick Park	1.0396	0.000	1.0317	1.0475
		Queen Elizabeth II	1.0496	0.000	1.0418	1.0575
		St Mary's	1.0027	0.441	0.9957	1.0098
		Watford	1.0670	0.000	1.0612	1.0729
		West Middlesex	0.9907	0.004	0.9846	0.9969
21	Admissions for ACS conditions Defined by Billings	Barnet	1.0000	-	-	-
		Ealing	1.0472	0.188	0.9777	1.1217
		Edgware	1.0665	0.014	1.0128	1.1231
		Hemel Hempstead	0.9760	0.247	0.9366	1.0170
		Hillingdon	1.0146	0.387	0.9818	1.0486
		Lister	1.0115	0.459	0.9812	1.0429
		Mt Vernon	0.9794	0.186	0.9497	1.0100
		Northwick Park	0.9561	0.000	0.9340	0.9788
		Queen Elizabeth II	1.0137	0.218	0.9919	1.0359
		St Mary's	0.9619	0.000	0.9427	0.9815
		Watford	1.0071	0.399	0.9906	1.0240
		West Middlesex	0.9922	0.354	0.9759	1.0087
23	Admissions for marker conditions Defined by Billings	Barnet	1.0000	-	-	-
		Ealing	0.9359	0.041	0.8784	0.9972
		Edgware	0.9925	0.751	0.9473	1.0397
		Hemel Hempstead	0.9338	0.000	0.9014	0.9673
		Hillingdon	0.9861	0.348	0.9578	1.0153
		Lister	1.0167	0.194	0.9916	1.0426
		Mt Vernon	1.0104	0.386	0.9869	1.0344
		Northwick Park	0.9825	0.065	0.9642	1.0011
		Queen Elizabeth II	1.0028	0.763	0.9847	1.0212
		St Mary's	0.9589	0.000	0.9421	0.9761
		Watford	1.0023	0.748	0.9884	1.0164
		West Middlesex	0.9956	0.542	0.9816	1.0098

Group B EDs